# On the functions of adult crying

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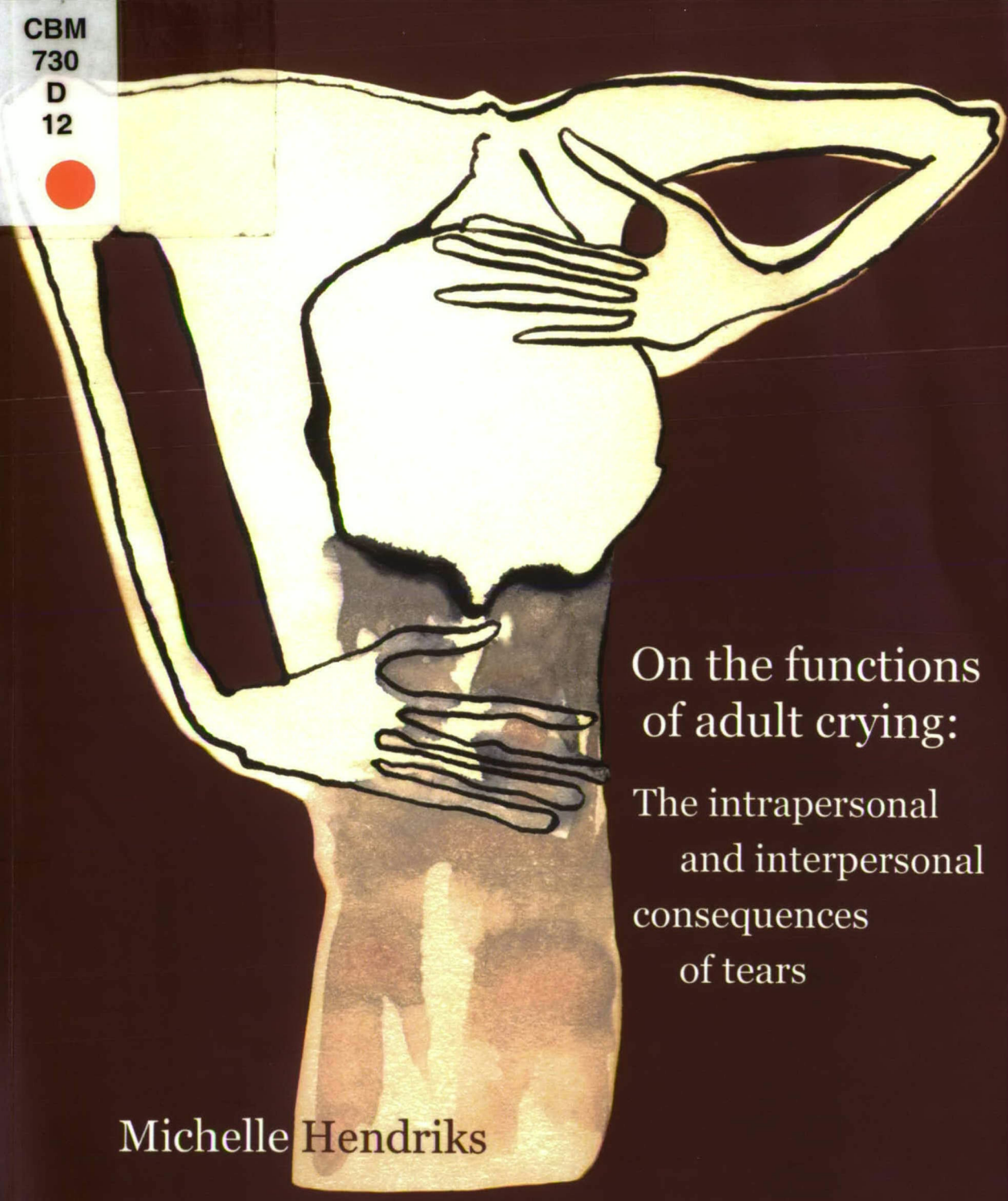
*Publication date:*
2005

*Document Version*
Publisher's PDF, also known as Version of record



# On the functions of adult crying:

## The intrapersonal and interpersonal consequences of tears

Michelle Hendriks

# ON THE FUNCTIONS OF ADULT CRYING:

## THE INTRAPERSONAL AND INTERPERSONAL CONSEQUENCES OF TEARS

PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Universiteit van Tilburg,
op gezag van de rector magnificus,
prof. dr. F. A. van der Duyn Schouten,

in het openbaar te verdedigen ten overstaan van een
door het college voor promoties aangewezen commissie
in de aula van de Universiteit
op vrijdag 25 februari 2005 om 14.15 uur

door

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geboren op 3 juni 1977 te Roosendaal (N.Br.)

Promotor: Prof. Dr. A. J. J. M. Vingerhoets


Printed by Universal Press, Veenendaal
Cover illustration: Monique Brands

ISBN 90-9019033-3
NUR 600, 770

The research reported in this thesis was conducted under the auspices of the Research Institute for Psychology & Health, an Institute accredited by the Royal Dutch Academy of Arts and Sciences.

# VOORWOORD

Aan het begin van dit boek wil ik graag nog een aantal mensen bedanken voor hun bijdrage aan, steun en afleiding bij de totstandkoming van mijn proefschrift. Ten eerste ben ik uiteraard mijn promotor Ad Vingerhoets zeer dankbaar. Ad, je betrokkenheid, enthousiasme en geloof in mij werkten erg stimulerend. Je deur stond (en staat nog steeds) altijd voor me open en de snelheid waarmee je feedback gaf op mijn vragen en stukken zorgden ervoor dat ik me nooit lang hoefde te vervelen. Ik wil je bedanken voor de prettige samenwerking.

Mijn dank gaat ook uit naar de andere coauteurs. Marcel Croon, jou wil ik bedanken voor je statistische ondersteuning en voor het uitvoeren van de multilevel analyses. Geert van Boxtel, bedankt dat je me de mogelijkheid hebt gegeven om ERP-data te verzamelen en voor je begeleiding bij dit experiment.

Geen promotie zonder de technische ondersteuning van Ton Aalbers en Charles Rambelje uit gang 4. Ik weet zelf helemaal niets van programmeren of het bouwen van een onderzoeksopstelling en een deel van de onderzoeken had niet kunnen plaatsvinden zonder jullie hulp. Daarnaast stonden jullie altijd voor me klaar als ik het weer voor elkaar kreeg om op een cruciale moment een of ander draadje stuk te maken. Het probleem was meestal dezelfde dag nog verholpen zodat ik verder kon met mijn onderzoek. Bedankt.

Tevens ben ik mijn dank verschuldigd aan alle mensen die als proefpersoon hebben deelgenomen aan de verschillende onderzoeken. Zonder hen had ik dit proefschrift niet kunnen schrijven, zij hebben immers de data geleverd. Vooral de studenten die hebben meegedaan aan het filmexperiment ben ik dankbaar omdat ze de metingen voor de pijnwaarneming zonder al te veel morren hebben ondergaan.

Mijn werk op de UvT was een stuk minder plezierig geweest zonder het contact met fijne collega's. Ik wil al mijn (aio-)collega's dan ook bedanken voor de (soms wat te) gezellige en levendige sfeer. De lunchpauze stipt om 12 uur was altijd een welkome onderbreking. Met name Helen en Annelies wil ik bedanken voor alle aangename momenten zowel tijdens als buiten het werk. Helen, ik had geen betere 'overbuuf' kunnen hebben. Het stipt om 8.42 uur even bijkletsen over de vorige avond en het samen lopen naar het station zijn dingen die ik zeker zal missen. Annelies, je was een geweldige kamergenoot. Niet alleen heb je mijn vocabulair

sterk uitgebreid (okked, asend), je luisterde altijd naar mijn verhalen of was juist stil wanneer er hard gewerkt moest worden. Jullie zijn goede vrienden geworden en ik ben blij dat jullie bij de verdediging van mijn proefschrift achter me zullen staan.

Mijn vrienden en familie ben ik dankbaar omdat ze het leven buiten mijn werk gezellig en betekenisvol maken. Mijn ouders wil ik bedanken dat ze me hebben gestimuleerd om voor het hoogst haalbare te gaan en dat ze er alle vertrouwen in hebben gehad dat me dat ook zou lukken. Daniëlle, ik ben blij dat jij mijn grote zus bent. Ik kan altijd bij je terecht, zowel om leuke dingen te ondernemen als voor steun in moeilijke tijden. De band die wij delen ervaar ik als zeer bijzonder en zou ik nooit willen missen.

Bob, hoewel je zelf niet inziet waarom je in mijn dankwoord zou moeten staan, kan je als belangrijkste persoon in mijn leven natuurlijk niet ontbreken. Bij jou kan ik volledig mezelf zijn of ik nu een goed of slecht humeur heb. Jij geeft me een thuis dat altijd de moeite waard is om naar toe te gaan.

Michelle Hendriks
Roosendaal, december 2004

# CONTENTS

# CHAPTER 1
# Introduction

Crying is a very common and universal form of human emotional expression. People of all ages and from all cultures cry on certain occasions to express their emotions (Vingerhoets & Cornelius, 2001; Vingerhoets, Cornelius, Van Heck, & Becht, 2000). In the present thesis, crying is defined as a complex secretomotor response with as its most prominent characteristic the shedding of tears in an emotional context without any irritation of the ocular structures (Patel, 1993; Vingerhoets et al., 2000). In addition, tears are often accompanied by alterations in the muscles of facial expression, by vocalizations, and in some cases by sobbing (Patel, 1993). Since no other species has the ability to shed emotional tears, crying is thought to be a uniquely human response (Bindra, 1972; Vingerhoets et al., 2000). In spite of this, to date, remarkable little scientific attention has been paid to this phenomenon. More specifically, although scientists since Darwin have theorized about the functions of tears, this question remains unanswered up to the present day. In order to get a better insight into the functions of crying, the present thesis examined its effects both on the crying person him/herself (*intrapersonal consequences*) and on the social environment (*interpersonal consequences*). The focus is on the consequences of emotional tears shed by adults leaving the crying of babies and children out of consideration.

## FUNCTIONS OF EMOTIONAL EXPRESSION IN GENERAL

Emotions are elicited during the interaction of a person with his or her environment, and arise when a person encounters an event that s/he appraises as important (i.e., either harmful or beneficial) to her/his concerns or goals (e.g., Frijda, 1988; Scherer, 2000; Vingerhoets et al., 2000). Emotions help us respond adaptively to environmental challenges and opportunities by organizing our thoughts and actions and shaping our behavior (e.g., Ekman, 1984; Frijda, 1986; Gross & Levenson, 1993; Levenson, 1994). Emotional responses are not unitary phenomena, but rather consist of several, partially independent, components or response modalities such as subjective experience, physiological responses, action tendencies and expressive behavior (e.g., Ekman, 1984; Gross & Levenson, 1993; Scherer, 2000; Vingerhoets et al., 2000). The component of emotional expression refers to the behavioral aspect of emotional reactions and is represented by, for instance, facial expressive behavior, vocal characteristics, posture and gesture.

In his seminal work on emotional expression, Darwin (1872/1965) stated that 'certain complex actions are of direct or indirect service under certain states of the mind, in order to relieve or gratify certain sensations, desires, etc; and whenever the same state of mind is induced, however feebly, there is a tendency through the force of habit and association for the same movements to be performed, though they may not then be of the least use' (p. 28). In addition, he claimed that actions of all kinds that are regularly accompanied by a particular state of mind are recognized as expressive of this state of mind. Once acquired, individuals may voluntarily and consciously employ these expressions as a means of communication. In other words, as concluded by Izard and Ackerman (2000), Darwin identified two adaptive functions of emotional expressions. In the first place, expressions are designed to regulate the emotional experience, and, in the second place, they provide a way to communicate with each other.

In recent scientific literature, these two functions of emotional expressions are still advocated. Clinical and health psychologists have mainly emphasized the effects of emotional expression on the expressing person him/herself and have claimed that expression results in catharsis, that is, that it provides psychological relief (for reviews see Berry & Pennebaker, 1993; Kennedy-Moore & Watson, 1999). By expressing emotions, excessive energy is released, which, subsequently, makes a person feel better. In addition, there is evidence that the active inhibition of emotional expression requires physiological effort (Berry & Pennebaker, 1993; Gross & Levenson, 1993; Vingerhoets & Scheirs, 2001), which may interfere with the recovery of psychological and physiological balance (see various contributions to Nyklícek, Temoshok, & Vingerhoets, 2004). The underlying idea is that suppressed emotions go underground and are discharged through other channels such as increased physiological arousal (Berry & Pennebaker, 1993; Gross, 1998; Gross & Levenson, 1993; Jones, 1950). Extending this argument, it has been hypothesized that expressing emotions is good for one's mental and physical health in the long run (Berry & Pennebaker, 1993).

In contrast, social-psychological theories have asserted that emotional expressions are foremost communicative signals that are employed in everyday social interactions. Concerning facial expressions, there exist three main perspectives on what kind of information is communicated. According to the *emotion expression view* (e.g., Ekman, 1972; Izard, 1977; Tomkins, 1962), emotions automatically give rise to facial behavior, which expresses the accompanying internal emotional feeling state. However, according to Fridlund's (1992, 1994) *behavioral ecology view*, facial expressions signal our social motives or intention to others and are by no means directly related to experienced emotions. Lastly, the *components view* (e.g., Carroll & Russell, 1997; Frijda & Tcherkassof, 1997; Manstead, Fischer, & Jakobs, 1999) combines the emotion expression view and the behavioral ecology view in stating that both emotional feelings and social motives can influence the occurrence and actual form of facial expressions. Despite

these theoretically important differences, all three perspectives acknowledge the communicative function of facial expressions and the possible influence of facial expressions on the social environment. A central assumption is that facial expressions and emotional expressions in general are designed to elicit or inhibit particular behaviors in other people, which may modify the emotional situation at hand for the better for the expressing individual (e.g., Cornelius, 1996; Cornelius & Labott, 2001; Frijda, 1997; Frijda & Mesquita, 1994; Kottler & Montgomery, 2001).

## MODEL OF ADULT CRYING

Vingerhoets et al. (2000) were the first to present a comprehensive, albeit preliminary, model of adult crying. This model mainly described the antecedents of crying and the moderating factors that might influence the actual occurrence of the shedding of tears. According to this model, the main appraisals that lead to a crying episode are that a person perceives a impending loss in a situation and/or sees no possibilities to handle the situation effectively (Vingerhoets et al., 2000). Situations that typically elicit adult crying are the death of a close loved one, the dissolution of romantic relationships or conflicts within such relationships, loss of work or status, and sad films or television programs that have loss as a main theme (Nelson, 1998, 2000; Vingerhoets et al., 2000; see also various contributions to Vingerhoets & Cornelius, 2001). While adult crying may be an expression of many different emotions, it is very often accompanied by feelings of powerlessness in combination with sadness and grief (Nelson, 1998, 2000; Vingerhoets, Boelhouwer, Van Tilburg, & Van Heck, 2001; Vingerhoets et al., 2000).

Whether or not a person will cry when exposed to a particular emotional stimulus is moderated by person factors (e.g., gender and physiological and psychological state) as well as context factors (e.g., the presence of others and cultural display rules; Vingerhoets et al., 2000). The most consistent finding in the crying research is that women cry more frequently, more intensely, and for a longer time than do men (see for a review Vingerhoets & Scheirs, 2000). Concerning individual differences, studies have yielded that empathy, extraversion, neuroticism and femininity are all positively associated with crying proneness (Vingerhoets et al., 2000). In addition, there is some indication that being tired and deprived of sleep lowers the threshold for crying (Wagner, Hexel, Bauer, & Kropiunigg, 1997), and that the tendency to cry might be related to the menstrual cycle and hormonal fluctuations (Eugster, Horsten, & Vingerhoets, 2001; Van Tilburg, Becht, & Vingerhoets, 2003). Regarding context factors, it appeared that the presence of other people could both facilitate and inhibit the shedding of tears (Vingerhoets et al., 2001). Moreover, the salience of social norms concerning crying in a certain situation is important. People are less likely to cry in a situation in which they anticipate disapproval of their tears than in a situation in which they foresee to receive empathy in response to their crying (Vingerhoets et al., 2000).

## FUNCTIONS OF ADULT CRYING

Following the proposed functions of emotional expressions in general, two possible functions of crying have been distinguished in the scientific literature (Gross, Fredrickson, & Levenson, 1994; Vingerhoets et al., 2000). First, crying may speed up the recovery of homeostasis after distress in the crying individual him/herself (*intrapersonal consequences*). Among the putative mechanisms responsible for these effects are that crying alleviates negative affects, and that crying decreases sympathetic nervous system activation (Gross et al., 1994). Second, it has been proposed that crying is primarily designed to communicate the need for help and to stimulate others to offer this help (*interpersonal consequences*).

### Intrapersonal consequences of crying

The belief that crying may result in some form of tension reduction and emotional catharsis is an old one. Although Darwin (1872/1965) considered tears as an incidental and purposeless side-effect of crying out, he also claimed that crying served as a relief to suffering, as is evident from the following citation: 'And by as much as the weeping is more violent or hysterical, by so much will the relief be greater, - on the same principle that the writhing of the whole body, the grinding of the teeth, and the uttering of piercing shrieks, all give relief under an agony of pain' (p.175). The basic assumption of a cathartic view on crying is that tears are the outcome of a hydraulic-like process in which negative affects must be given some more or less direct expression (Cornelius, 2001). Tears represent the overflowing of emotions that have passed a critical level. Through crying energy that was mobilized during distress is released, and an excessive buildup of emotions is avoided (Sadoff, 1966). Additionally, it has been suggested that the failure to cry when it is called for results in a discharge of the emotional tension through other means, which is hypothesized to be potentially harmful and leading to a variety of physical and psychological complaints (Cornelius, 2001; Groen, 1957). To quote the famous British physician Sir Henry Maudsley, 'sorrows which find no vent in tears may soon make other organs weep' (in Frey II & Langseth, 1985, p. 104).

Several other researchers (e.g., Bindra, 1972; Gross et al., 1994; Kraemer & Hastrup, 1988) have suggested that intense emotions lead to excessively high levels of sympathetic activity, which may be followed by a rebound of parasympathetic activation that serves to dampen this activity and restore homeostasis. Although the lacrimal gland, which is responsible for the production of tears, is innervated by both the parasympathetic and sympathetic nervous system, only the stimulation of parasympathetic fibers of the seventh cranial nerve results in an increased tear secretion (Gross et al., 1994; Rottenberg, Wilhelm, Gross, & Gotlib, 2003; Van Haeringen, 2001). It has been proposed that tears are the result of the temporary parasympathetic overcompensation after distress (Bindra, 1972; Efran & Spangler, 1979; Gross et al., 1994) or, the other way around, that they stimulate the

parasympathetic nervous system and thus cause this rebound mechanism (Rottenberg et al., 2003).

**Interpersonal consequences of crying**

The effects of crying on the social environment have also received the attention of researchers (Vingerhoets et al., 2000). Kottler (1996) speculated that crying is uniquely human because human newborns develop relatively slow and therefore for a considerably long time need the help of others to take care of them. In agreement with Darwin (1872/1965), it has been asserted that crying is an expressive display whose primary function is to communicate to others and oneself in an unambiguous way that one is vulnerable, suffering and in need of aid (Fridlund, 1992; Frijda, 1997; Yik & Russell, 1999). The main function of crying may be to beckon others to help remove a given source of discomfort, and to elicit attention, empathy and support (Frijda, 1997; Kottler & Montgomery, 2001; Vingerhoets et al., 2000). Crying might additionally signal the message to back off and inhibit aggressive impulses of potential aggressors (Kottler & Montgomery, 2001). It is, however, also acknowledged that tears, in particular tears that are perceived as not sincere, may evoke frustration, irritation and submission from others (Frijda, 1986, 1997; Hill & Martin, 1997; Nelson, 2000).

From a different theoretical perspective, adult crying has been regarded as an attachment behavior. Attachment behaviors are designed to elicit caregiving responses from significant others (Bowlby, 1969). Attachment behaviors such as crying, smiling, and reaching typically trigger a reciprocal set of caretaking behaviors in others such as touch, soothing and nurturance (Bowlby, 1969). These behaviors serve to establish and maintain the parent-child bond (Ainsworth, Blehar, Waters, & Wall, 1978) and romantic adult bonds as well (Hazan & Zeifman, 1999). Attachment research has shown that crying is an inborn behavior that functions to call for and assure the protective and nurturing presence of caregivers (Bell & Ainsworth, 1972; Bowlby, 1969; Cassidy, 1999; Zeifman, 2001), and it has been proposed that tears continue to be an attachment behavior throughout life (Bowlby, 1969).

In short, crying might be essential for human adaptation and survival because it possibly serves two important functions. First it may restore our physiological and psychological balance after distress, and, second it may efficiently elicit help from others when needed. However, so far, only a few empirical studies have specifically focused on the intrapersonal and interpersonal consequences of tears. Therefore, the objective of the present thesis was to examine if crying indeed has the supposed beneficial effects on the crying person him/herself and on the social environment.

## RESEARCH STRATEGY OF THE PRESENT THESIS

According to Keltner and Gross (1999), the functions of emotions (read: crying) can be derived from studies on specific causes and consequences of a particular emotion within the current environment. Functions of behaviors are often equated with their regular beneficial consequences, both in terms of proximal and distal benefits. Function-related consequences are those reliable effects that a behavior was specifically 'designed' to bring about (Averill, 1994; Keltner & Gross, 1999). According to Keltner and Gross (1999), one way to study the functions of emotions is to experimentally activate or deactivate that emotion and to systematically explore the intrapersonal and interpersonal consequences of these manipulations.

Correspondingly, in the present thesis, some studies are described that examined the effects of crying on the crying person him/herself and on the social environment. The intrapersonal consequences of tears were investigated by exposing participants to an emotionally arousing film. Participants who cried and did not cry during this particular film were, subsequently, compared on variables such as mood and physiological arousal. In order to determine the social reactions to crying, we examined how individuals react to a crying person compared to a non-crying person. Participants responded to descriptions of situations in which another person cried or did not cry or rated photographs of crying and non-crying faces.

## OVERVIEW OF THE CHAPTERS OF THE PRESENT THESIS

The objective of the present thesis was to find out which functions crying might serve in adult human beings. Therefore, empirical studies were performed that examined both the intrapersonal and interpersonal consequences of the shedding of emotional tears. In the next two chapters, the effects of crying on the crying person him/herself are presented. This concerned a study in which female participants were exposed to an emotionally arousing film that was expected to induce a crying response in a subgroup of the participants. Chapter 2 addresses the influence of crying and the suppression of tears on mood and pain perception. To this aim, mood and pain perception were measured before and after the film, and participants were asked to indicate whether they cried and/or whether they suppressed their tears during the film.

Chapter 3 describes the influence of crying on the physiological arousal of the crying person him/herself. Several physiological parameters were measured while participants watched a neutral and an emotionally arousing film. In order to determine specifically the effects of crying on the activity of the sympathetic and parasympathetic nervous system, the pre-ejection period and respiratory sinus arrhythmia were measured respectively. The changes in the psychophysiological variables were compared for crying and non-crying participants.

The following three chapters deal with the social reactions to crying. In Chapter 4, a scenario study is presented on the influence of the crying of another person on the participants. A questionnaire containing six different situations in which another person cried or did not cry was administered to the respondents. The sex of the (non-)crying person and the relationship with the (non-)crying person were varied between subjects. In addition, the sex of the respondent was considered an important variable. Participants had to indicate for each situation how they perceived the (non-)crying person, how they felt, and how they would behaviorally respond to the (non-)crying person.

The objective of the study described in Chapter 5 was to determine how people respond to crying expressions as compared to other facial expressions. Respondents were exposed to photographs of male and female faces depicting neutral, crying, angry and fearful expressions. Participants reported how they perceived the person on the photo, and how they would feel and react in the presence of the person. It was examined whether the type of expression, the sex of the poser, the sex of the respondent, and the interactions between these factors determined the social reactions to facial expressions.

Chapter 6 addresses the cortical processing of facial expressions, including crying faces. Participants viewed photographs of faces depicting six different expressions, namely neutral, crying, non-crying (i.e., crying faces with the tears digitally removed), anger, fear and laughing. Meanwhile, electroencephalographic (EEG) recordings were made. The aim of this study was to determine whether the characteristics of two face-specific event-related potential (ERP) components (i.e., N170 and VPP) differed for crying expressions, on the one hand, and neutral expressions and expressions of basic emotions, on the other hand.

Finally, Chapter 7 summarizes the most important findings of the present thesis and discusses the implications for the functions of crying. The limitations of the here presented studies are considered and suggestions for further research are put forth.

# PART I
# INTRAPERSONAL CONSEQUENCES

psychological complaints (Cornelius, 2001; Groen, 1957). To quote the famous British physician Sir Henry Maudsley, 'sorrows which find no vent in tears may soon make other organs weep' (in Frey II & Langseth, 1985, p. 104).

Several studies have examined the supposed mood-relieving effects of crying (for a review see Cornelius, 1997a, 2001). These studies have yielded mixed results, apparently depending on the design of the study. Cornelius (1997a) identified eight retrospective studies in which participants were asked to remember a recent crying episode or to report how they generally feel after a crying episode. All these studies suggested that crying makes people feel better. In a similar vein, data from the International Study on Adult Crying (ISAC) collected in 30 countries revealed that both men and women reportedly experienced marked positive changes in their mood following crying (Becht & Vingerhoets, 2002). However, of six quasi-experimental studies in which participants were exposed to a sad film, one study demonstrated no effect and five studies revealed a negative effect of the shedding of emotional tears on mood (Cornelius, 1997a, 2001). In the study of Gross et al. (1994), for instance, people who cried while watching a sad film reported having experienced more sadness, embarrassment and pain during the film than individuals who did not cry.

One possible explanation for these divergent findings is that in the retrospective studies the reported mood-effects of crying were mostly determined by implicit theories held by the participants rather than by the actual effect on mood. Relevant in this context is that research on the relationship between crying and the menstrual cycle has revealed that women retrospectively report more crying during the premenstrual period, whereas diary studies show no relation between crying frequency and the menstrual cycle (Van Tilburg et al., 2003). In other words, the recall of symptoms during the menstrual cycle appeared to be affected by a woman's belief about which symptoms she should experience (Marván & Escobedo, 1999). Since the popular account of crying suggests that we should feel better after crying (see Cornelius, 1986, April), the self-report of crying experiences may be biased in favor of this idea. In contrast, in the laboratory studies, the participants had to rate their mood before and after exposure to a sad film and were not directly requested to indicate the effects of crying on their mood. Therefore, the implicit theories on crying were not incited in these quasi-experimental studies and consequently did not play a role. Alternative explanations for the inconsistency in results emphasize aspects like the time interval between the crying episode and the mood assessment, the intensity and duration of the crying episode, and the possible moderating role of the social environment (e.g., Cornelius, 2001; Kraemer & Hastrup, 1988).

As mentioned previously, the suppression of tears is believed to have a negative influence on the relief of emotional tension. It is a basic assumption that the active inhibition of emotions and behavior in general requires physiological effort (Berry & Pennebaker, 1993; Gross & Levenson, 1993; Vingerhoets & Scheirs, 2001), which may interfere with the recovery of psychological and physiological

# CHAPTER 2
# The influence of crying on mood and pain perception*

## INTRODUCTION

Crying in adults is a ubiquitous and distinctly human form of emotional expression (Kraemer & Hastrup, 1988; Vingerhoets & Cornelius, 2001; Vingerhoets et al., 2000). Despite its widespread occurrence, however, several basic questions concerning crying still have to be answered. More specifically, the functional significance of the shedding of emotional tears has yet to become a subject of systematic research.

Scientists have distinguished two possible functions of crying (Gross et al., 1994; Vingerhoets et al., 2000). First, crying may facilitate the recovery of psychological and physiological homeostasis after distress in the crying individual him/herself. One mechanism that has been opted to be responsible for these effects is that crying alleviates negative affects (Gross et al., 1994). Second, it has been proposed that crying is primarily designed to communicate the need for help and to stimulate others to offer this help and/or to provide comfort and emotional support (Frijda, 1997; Kottler, 1996; Nelson, 2000). In the present study, the hypothesis that crying facilitates the recovery of homeostasis and promotes well-being was explored.

The belief that crying may result in some form of pain reduction and emotional catharsis is an old one. Darwin (1872/1965), for instance, formulated it as follows: 'And by as much as the weeping is more violent or hysterical, by so much will the relief be greater, - on the same principle that the writhing of the whole body, the grinding of the teeth, and the uttering of piercing shrieks, all give relief under an agony of pain' (p.175). A basic assumption of the cathartic model of crying is that tears are the outcome of a hydraulic-like process in which negative affects must be given some more or less direct expression (Cornelius, 2001). Tears represent the overflowing of emotions that have passed a critical level. In this way, there is a release of the energy that was mobilized during distress, and an excessive buildup of emotions is avoided (Sadoff, 1966). A related belief is that the failure to cry when it is called for results in a discharge of the emotional tension through other means. This discharge may be harmful in one way or another, leading to a variety of physical and

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* Hendriks, M. C. P. & Vingerhoets, A. J. J. M. (submitted). The influence of crying on mood and pain perception.
The present study has been approved by the medical ethical committee of the TweeSteden Hospital in Tilburg, the Netherlands.

balance. Accordingly, Gross and colleagues (Gross, 1998; Gross & Levenson, 1993, 1997) have demonstrated that the inhibition of emotional expressive behavior results in an increased activation of the sympathetic nervous system. Other research has revealed that the inhibition of negative emotions is even possibly associated with health-related problems such as cancer, high blood pressure and ulcers (Berry & Pennebaker, 1993). Unfortunately, no previous research has focused on the effects of the inhibition of crying on mood. While Kraemer and Hastrup (1988) and Labott, Ahleman, Wolever, and Martin (1990) instructed participants to express or inhibit their crying in response to a sad film and measured mood, they did not check whether the non-crying individuals in the inhibition condition had the urge to cry to begin with. As pointed out by Berry and Pennebaker (1993), low expressivity may not necessarily be the same as high inhibition. It is therefore important to determine the effects of the inhibition of crying on the crying person him/herself, since it might be that crying does not necessarily restore the physical or psychological balance but that the inhibition of tears influences this recovery negatively.

The laboratory studies on the mood-effects of crying reviewed by Cornelius (1997a, 2001) all used a sad film to induce a crying episode. Another line of research that has also used sad film-fragments as stimulus material examined the influence of mood on pain perception. In this way, Zillmann, Rockwell, Schweitzer, and Sundar (1993) and Weaver and Zillmann (1994; for male participants only) found that the pain threshold and tolerance increased following exposure to a sad film. However, Weaver and Zillmann (1994; for female participants only) and Weisenberg, Raz, and Hener (1998) revealed that exposure to a sad film did not have any influence on the reported discomfort threshold; and Zillmann, De Wied, King-Jablonski, and Jenzowsky (1996) demonstrated a diminished pain tolerance after watching a sad film*. One may speculate that these inconsistent results can be explained by differences in the amount of crying by the participants. It may be that the changes in pain threshold and pain tolerance after exposure to emotional stimulation depend on the reactions of the individual to this stimulation. More precisely, it could be hypothesized that the pain threshold and pain tolerance only increase if the person expresses his/her emotion, for instance through crying, whereas suppressing one's emotion may result in a decreased tolerance.

In the present study, we aimed to determine the effects of crying and the suppression of tears on mood and pain perception. Female participants were exposed to an emotionally arousing film that was expected to induce a crying episode in a subgroup of the participants. Mood and pain perception were measured before and after the film, and participants were asked to indicate whether they had cried and/or whether they had suppressed their tears during the film. We expected that crying

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* Note that all studies mentioned here measured pain perception after and not while watching the film fragments, and thus did not concern the influence of distraction on pain perception.

would have no effect on mood and pain perception, but that the inhibition of crying would have a negative influence on both mood and pain perception.

A second objective of the present study was to determine whether implicit theories on the effects of crying held by participants could explain the previous found inconsistency concerning the mood effects of crying. Before watching the film, participants were asked to indicate how a crying episode generally affects their mood. In addition, those participants who had cried during the film were four weeks later requested to report on the mood effects of this particular crying spell. This allowed for the comparison of the self-reported effects of crying on mood with the effects of crying found during the film session. It was anticipated that participants would report that their mood improved after a crying spell, whereas in the film session no beneficial mood-effects would be found.

## METHOD

### Overview

The present study consisted of three separate sessions. In the first and last session, participants filled in some questionnaires. During the second session ('film session') participants watched two films, a neutral and an emotionally arousing film, and mood and pain perception were measured. Pain perception was measured at the following time points: (1) before the neutral film; (2) in between the neutral and the emotionally arousing film; and (3) after the emotionally arousing film. Preceding and following each pain-perception measurement participants rated their current mood. The neutral film was always shown before the emotionally arousing film in order to familiarize participants with the procedures and the experimental setting. Since the present study was part of a larger project, some psychophysiological variables were measured while the participants watched the two films. The results of these variables fall outside the scope of this paper and will be presented elsewhere.

### Participants

Sixty female psychology students took part in the present study. Forty of them were first-year students, who received course credit for participation, and the remaining 20 students were second- or third-year students, who received a financial reward (30 euro) for participation. Data of three (all first-year) students had to be excluded due to equipment failure. The age of the final group varied from 18 until 32 years ($M$ = 20.7, $SD$ = 2.9). Exclusion criteria were the presence of any severe chronic physical or psychiatric illness, the use of medication other than hormonal contraceptives, and being pregnant.

### Stimulus material

A National-Geographic documentary entitled Natural Balance was used as neutral film (Nixon, 1994). This documentary lasted about 15 minutes and showed

researchers who studied animals in their natural habitat. As for the emotionally arousing film, 'Once were warriors' (OWW; Scholes & Tamahori, 1994) was selected. This film depicts the life of a Maori family in New Zealand that is tyrannized by the father. It shows dramatic scenes of extreme violence, rape and suicide. Previous research revealed that female students experience strong emotional reactions while watching this film (Van Tilburg & Vingerhoets, 2002). For the present study, a selection of scenes of OWW was shown resulting in a film of about 70 minutes. Both films were displayed on a 70 cm (27.6 inch) television monitor placed approximately 3.30 m (10.8 ft) away from the participant. Sound was presented through a Dolby surround-system.

**Measurements**

*Crying behavior during the film OWW*

Participants were asked to press a button every time they cried while watching the film OWW. In the instructions, crying was referred to as anything from tears in one's eyes until running eyes and sobbing. After the film, participants additionally indicated how often they felt the urge to cry during the film OWW but suppressed their tears, and how often they actually had tears in their eyes during the film OWW.

*Pain-perception assessment*

For the measurement of pain perception the procedure described by Nyklícek, Vingerhoets, and Van Heck (1999) was employed. Using a Tursky concentric electrode (Tursky, 1974), constant electric current was delivered to the ventral side of the left forearm of the participants. The skin below the electrode was lightly abraded in order to keep the skin resistance below 5 kOhm. The current was a 60 Hz bipolar 50%-duty square pulse, which could reach a maximum of 6 mA. In the present study, only the slow automatic intensity-regulation of Nyklícek et al. (1999) was administered. This means that the current was raised automatically in a linear fashion starting from 0 mA to the maximum of 6 mA in 40 s unless the participant terminated the stimulus earlier. Participants were asked to indicate by pushing a button (a) when the stimulus was perceived for the first time (*sensory threshold*); (b) when it was experienced as painful (*pain threshold*); and (c) when it reached the point to be 'unpleasant to a degree that one wanted to terminate the current' (*pain tolerance*), at which point the stimulation stopped immediately. In order to get a more reliable measurement, three trials were performed at each time point, and means were calculated and taken as input for the statistical analyses. Since the focus of the present study was on the effects of the film OWW and the accompanying crying behavior on pain perception, the statistical analyses were limited to the pain-perception measurements taken before and after watching the film OWW.

*Mood ratings*
Participants reported their current mood preceding and following the three pain-perception measurements. Each time, the following 18 mood indicators were rated on a Likert scale varying from 1 (not at all) to 10 (very much): relaxed, powerless, pitiful, happy, disgust, sad, relieved, astonished, angry, guilty, under control, tense, fearful, cheerful, restless, bad tempered, touched and nervous. Average scores were calculated for positive and negative mood-indicators separately. The positive mood-scores included the mood indicators relaxed, happy, relieved, under control and cheerful ($\alpha$ ranged between .71 and .81), and the negative mood-scores included the items powerless, pitiful, disgust, sad, astonished, angry, guilty, tense, fearful, restless, bad tempered, touched and nervous ($\alpha$ ranged between .78 and .89). Since we were interested in the effects of the film OWW and the accompanying crying behavior on mood, the statistical analyses focused on the mood ratings taken right before and right after participants watched the film OWW.

*General effects of crying on mood*
During the first session, participants were requested to indicate whether they generally experience some specific moods less (-1), the same (0) or more (+1) after a crying spell as compared with before. The same 18 mood indicators as mentioned above were rated. Average scores were calculated for positive moods and negative moods separately.

*Mood change due to crying reported four weeks later*
Four weeks after the film session, the participants who had cried during the film were requested to indicate whether they had experienced the above-mentioned 18 moods less (-1), the same (0) or more (+1) after this particular crying spell as compared with before. Average scores were calculated for positive moods and negative moods separately.

**Procedure**
After their entry, potential participants were screened regarding the exclusion criteria. If they did not meet any of these criteria, the students received detailed information about the procedures of the study and were given one week to think over their participation. Those who volunteered to participate subsequently signed informed consent and appointments were made for three separate sessions. The first session was a group or individual session in which the participants filled in some questionnaires and among other things answered the questions concerning the general effects of crying on their mood.

The second session ('film session') was an individual session during which the participants watched the two films and mood and pain perception were measured. After having welcomed the participants, the researcher (MH) explained

the procedure for the film session once again. Subsequently, after lightly having abraded the skin with alcohol, the necessary electrodes for measuring pain perception and for recording the heart rate and impedance cardiograph were attached. Participants were seated in a comfortable chair and rated their mood for the first time. The current-delivery apparatus was connected and the participants were carefully instructed concerning the procedure of the pain-perception assessment. Next, the pain perception was determined for the first time after which the mood was rated. Subsequently, the apparatus for measuring the psychophysiological variables were attached. The researcher started the neutral film and left the room. During the films, participants could communicate with the researcher through an intercom.

At the end of the neutral film, the researcher re-entered the room and the participants filled in the mood questionnaire, completed the pain-perception procedure and filled in the mood questionnaire again. Before the emotionally arousing film was shown, the experimenter instructed the participants to press a button every time they cried (i.e., at least felt their eyes becoming wet) during the film. Then, the film OWW was started and the researcher left the room again. Immediately after the film, the apparatus to measure the psychophysiological variables were detached. The participant rated their mood, answered some questions about the film OWW and indicated whether they had cried and/or whether they had suppressed their tears during the film OWW. Next, the pain perception was measured and participants rated their mood for the last time. In the end, all electrodes and the current-delivery apparatus were removed and participants were thanked for their participation.

Approximately four weeks after the film session, participants came back and those who had cried during the film OWW answered the questions about the mood change caused by this particular crying episode.

## RESULTS

Twenty-eight (49.1%) of the 57 participants indicated that they had at least cried once during the film OWW, and 38 (66.7%) participants indicated that they had at least once suppressed their tears during the film OWW. The participants who had cried during the film OWW indicated that they had shed tears between 1 and 4 times (*median* = 2), and the participants who had suppressed their tears indicated that they had done this between 1 and 6 times (*median* = 2). Moreover, 14 (24.6%) students reportedly had never suppressed their tears and had never cried; 15 (26.3%) participants had at least once suppressed their tears but had never cried; 5 (8.8%) students had never suppressed their tears but had at least once cried; and 23 (40.4%) individuals had at least once suppressed their tears and had at least once cried.

**Effects of crying and suppression of tears**

Separate repeated measures analyses of variance were performed on the positive and negative mood-scores and on the three pain-perception indices with time point (before and after the film) as a within-subjects factor and crying (no/yes) and suppression of tears (no/yes) as between-subjects factors. The results of the repeated measures analyses are summarized in Table 1 and Table 3, and the means of mood and pain perception are represented in Table 2 and 4.

*Mood*

The positive-mood score of the participants did not change from before to after watching the film OWW and was not influenced by crying or suppressing of one's tears. Participants did report a higher negative-mood score after the film OWW than before. In addition, the three-way interaction between time point, crying and suppression of tears significantly influenced the reported negative mood. To further examine this interaction effect, we performed repeated measures analyses for non-suppressing and suppressing individuals separately with time point as a within-subjects factor and crying as a between-subjects factor. For the participants who did not suppress their tears the concerning interaction approached significance ($F$ = 4.35, $p$ = .05, *partial* $\eta^2$ = .20) indicating that the negative mood increased more for crying participants than for non-crying participants (see Figure 1). The interaction between time point and crying was not significant for the participants who suppressed their tears ($F$ = 0.79, $p$ = .38, *partial* $\eta^2$ = .02; see Figure 2).

**Table 1.** Summary of the repeated measures analyses on mood

| Source | Positive mood | | | Negative mood | | |
|---|---|---|---|---|---|---|
| | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ |
| | | Between subjects | | | | |
| Crying | 1 | 0.65 | .01 | 1 | 1.26 | .02 |
| Suppression of tears (S) | 1 | 2.16 | .04 | 1 | 1.92 | .04 |
| C x S | 1 | 0.71 | .01 | 1 | 0.11 | .00 |
| | | Within subjects | | | | |
| Time point (T) | 1 | 1.35 | .03 | 1 | 205.68*** | .80 |
| T x C | 1 | 0.27 | .01 | 1 | 1.57 | .03 |
| T x S | 1 | 0.24 | .00 | 1 | 1.47 | .03 |
| T x C x S | 1 | 0.37 | .01 | 1 | 4.91* | .09 |

*Note.* * $p < .05$. *** $p < .001$.

**Table 2.** Mean mood-scores (with standard deviations in parentheses) as reported before and after watching the film OWW

| | Positive mood | | Negative mood | |
|---|---|---|---|---|
| | Before | After | Before | After |
| Non-crying | | | | |
| Non-suppressing (n = 14) | 5.9 (1.2) | 5.8 (1.9) | 2.1 (0.8) | 3.3 (1.3) |
| Suppressing (n = 15) | 4.9 (1.6) | 4.8 (1.5) | 2.1 (0.7) | 4.1 (1.4) |
| Crying participants | | | | |
| Non-suppressing (n = 5) | 5.2 (1.4) | 5.1 (0.6) | 2.0 (0.8) | 4.0 (1.7) |
| Suppressing (n = 23) | 5.2 (1.6) | 4.6 (1.6) | 2.7 (1.3) | 4.5 (1.3) |

*Pain perception*

None of the pain-perception indices changed from before to after watching the film OWW. Concerning the pain threshold, the interactions time point x crying and time point x suppression of tears both reached significance. In order to get a better insight into these interactions, repeated measures analyses were performed for each level of the between-subjects factor separately with time point as a within-subjects factor. These follow-up analyses demonstrated that the pain threshold increased for non-crying participants ($F = 4.90$, $p < .05$, *partial* $\eta^2 = .15$), but not for crying participants ($F = 2.63$, $p = .12$, *partial* $\eta^2 = .09$; see Figure 3). The pain threshold did not change for both non-suppressing and suppressing individuals ($F = 0.70$, $p = .80$, *partial* $\eta^2 = .00$ and $F = 0.34$, $p = .56$, *partial* $\eta^2 = .01$, respectively; see Figure 4).

While the main effects of crying and suppressing one's tears did not influence the sensory threshold, they did have an effect on the pain threshold and pain tolerance. Across measurements, crying participants had a higher pain threshold and tolerance than non-crying participants, and participants who suppressed their tears had a lower pain threshold and tolerance than participants who did not suppress their tears. Additionally, for pain threshold and pain tolerance a significant interaction between crying and suppression of tears was found. In both instances, crying influenced the pain perception of the non-suppressing individuals (both $F$s $> 9.79$, $p$s $< .01$, *partial* $\eta^2$s $> .37$), but not of the suppressing individuals (both $F$s $< 0.11$, $p$s $> .74$, *partial* $\eta^2$s $< .003$). Figure 5 and 6 demonstrate that participants who never suppressed their tears but did cry reported a higher pain threshold and pain tolerance than the other participants.

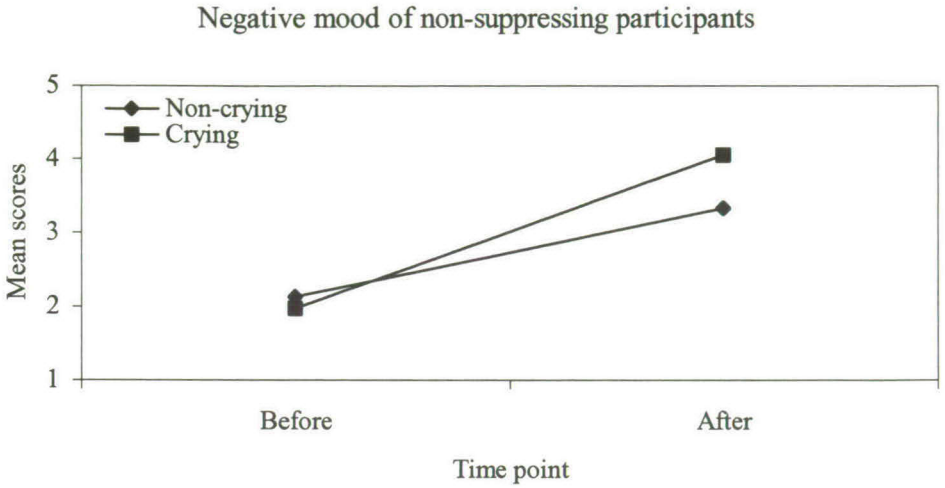


**Figure 1.** Means of negative mood reported before and after watching the film OWW as a function of crying for non-suppressing participants (n = 19)

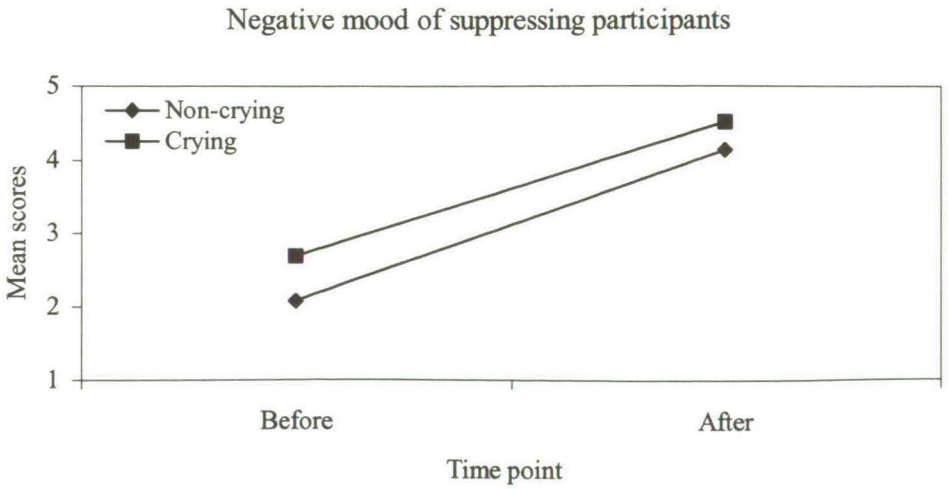


**Figure 2.** Means of negative mood reported before and after watching the film OWW as a function of crying for suppressing participants (n = 38)

**Table 3.** Summary of the repeated measures analyses on pain perception

| Source | Sensory threshold | | | Pain threshold | | | Pain tolerance | | |
|---|---|---|---|---|---|---|---|---|---|
| | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ |
| Between subjects | | | | | | | | | |
| Crying | 1 | 1.17 | .02 | 1 | 6.41* | .11 | 1 | 5.27* | .09 |
| Suppression of tears (S) | 1 | 0.66 | .01 | 1 | 7.85** | .13 | 1 | 10.17** | .16 |
| C x S | 1 | 0.56 | .01 | 1 | 8.42** | .14 | 1 | 6.63* | .11 |
| Within subjects | | | | | | | | | |
| Time point (T) | 1 | 0.84 | .02 | 1 | 1.10 | .02 | 1 | 0.23 | .00 |
| T x C | 1 | 3.35 | .06 | 1 | 13.03** | .20 | 1 | 0.09 | .00 |
| T x S | 1 | 0.24 | .00 | 1 | 4.12* | .07 | 1 | 0.20 | .00 |
| T x C x S | 1 | 0.01 | .00 | 1 | 3.30 | .06 | 1 | 1.17 | .02 |

*Note.* * $p < .05$. ** $p < .01$.

**Table 4.** Mean scores for pain perception in mA (with standard deviations in parentheses) reported before and after watching the film OWW

| | Sensory threshold | | Pain threshold | | Pain tolerance | |
|---|---|---|---|---|---|---|
| | Before | After | Before | After | Before | After |
| Non-crying | | | | | | |
| Non-suppressing (n = 14) | 0.6 (0.2) | 0.6 (0.2) | 1.5 (0.7) | 1.7 (0.8) | 2.9 (1.2) | 2.9 (1.1) |
| Suppressing (n = 15) | 0.6 (0.2) | 0.6 (0.3) | 1.6 (0.8) | 1.7 (1.0) | 2.7 (1.3) | 2.6 (1.3) |
| Crying participants | | | | | | |
| Non-suppressing (n = 5) | 0.8 (0.3) | 0.7 (0.3) | 3.3 (0.7) | 2.7 (1.1) | 4.8 (1.1) | 4.6 (1.1) |
| Suppressing (n = 23) | 0.6 (0.3) | 0.6 (0.3) | 1.6 (0.9) | 1.5 (0.8) | 2.5 (1.4) | 2.6 (1.3) |

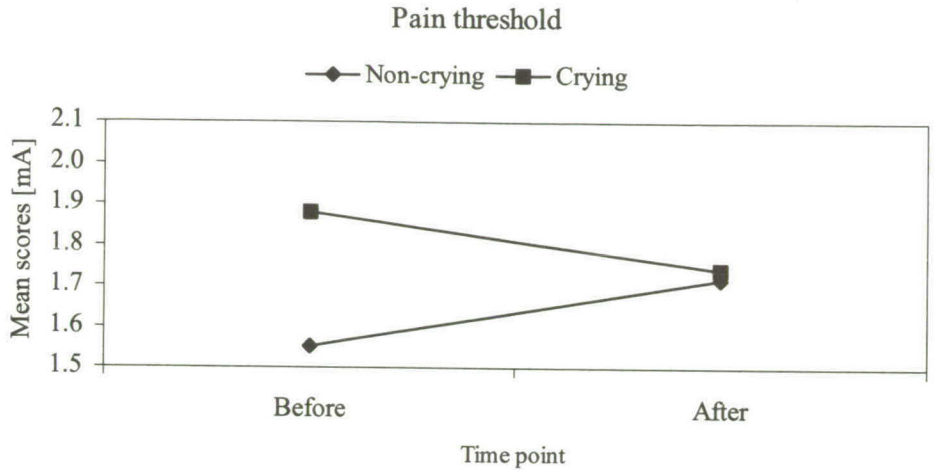


**Figure 3.** Means of pain threshold reported before and after watching the film OWW as a function of crying

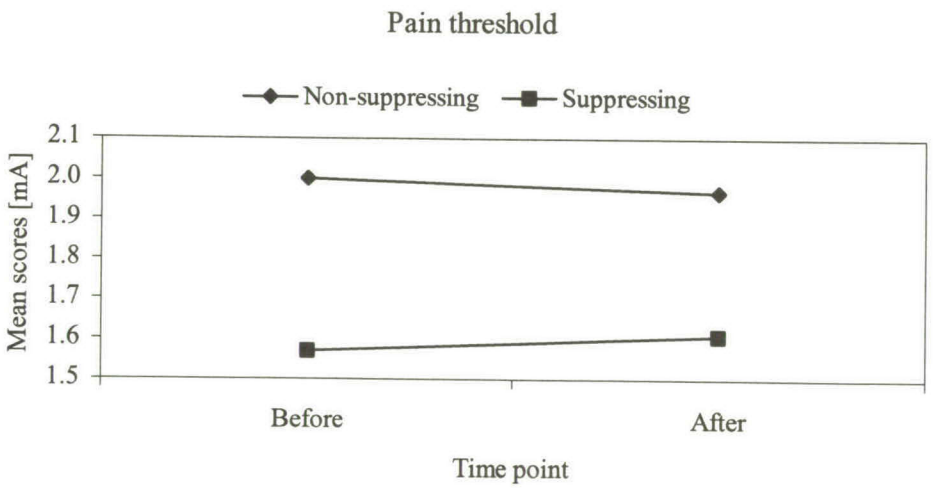


**Figure 4.** Means of pain threshold reported before and after watching the film OWW as a function of suppression of tears

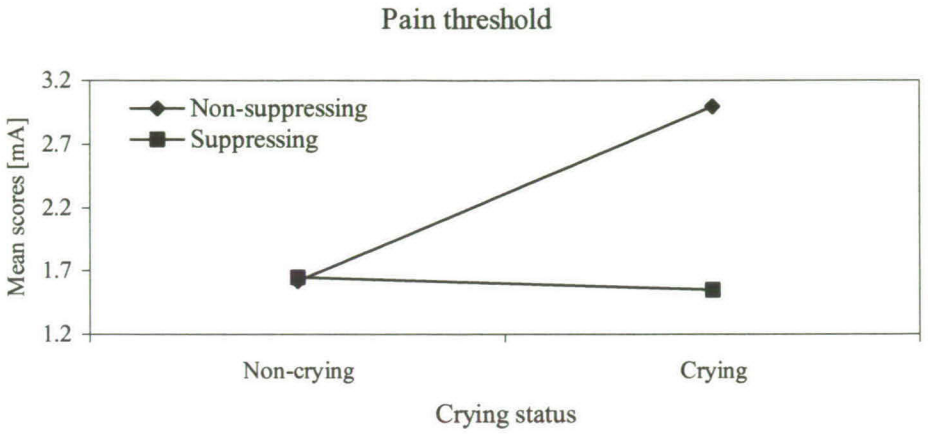


**Figure 5.** Pain threshold averaged over time points (i.e., before and after the film OWW) as a function of crying and suppression of tears

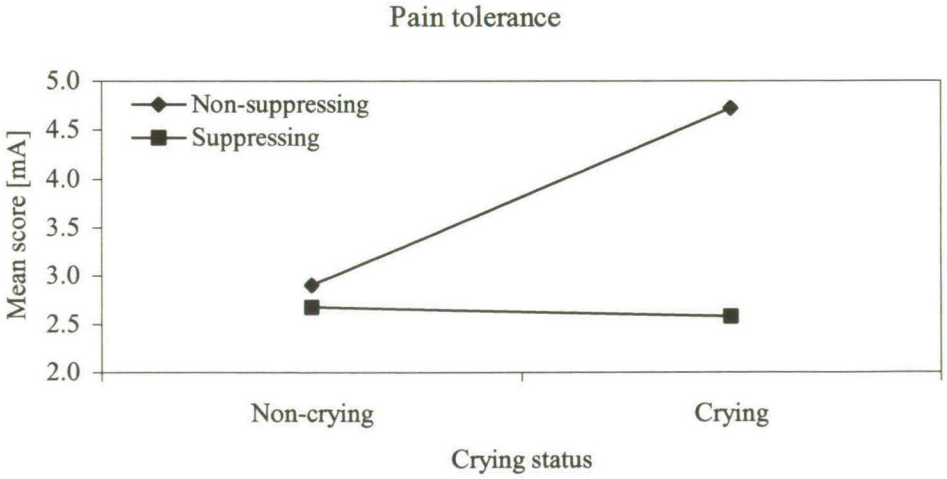


**Figure 6.** Pain tolerance averaged over time points (i.e., before and after the film OWW) as a function of crying and suppression of tears

**Influence of implicit theories on the reported mood-effects of crying**

Participants indicated that they generally felt more positive and less negative after a crying spell as compared with before (see Table 5 for means). Four weeks after the film session, the crying participants indicated that both their positive mood and negative mood did not change as a consequence of their crying during the film OWW; the reported changes in both positive mood and negative mood did not differ from zero ($t = 0.35$, $p = 0.73$ and $t = -0.14$, $p = 0.89$, respectively).

To compare the reported general effects and the effects reported four weeks after crying during the film OWW (i.e., specific effects), separate repeated measures analyses of variance were conducted on the changes in positive and negative mood with measurement (general versus specific effects) as a within-subjects factor. These analyses demonstrated that the reported general effects of crying differed from the reported specific effects ($F = 45.72$, $p < .001$, *partial* $\eta^2 = .64$ and $F = 33.53$, $p < .001$, *partial* $\eta^2 = .56$, for positive mood and negative mood respectively).

**Table 5.** Mean scores (with standard deviations in parentheses) for reported effects of crying on mood

| | General effects of crying | | Effects of crying four weeks later | |
|---|---|---|---|---|
| | Positive mood | Negative mood | Positive mood | Negative mood |
| Non-crying | | | | |
| Non-suppressing (n = 14) | 0.8 (0.3) | -0.5 (0.2) | | |
| Suppressing (n = 15) | 0.7 (0.3) | -0.6 (0.3) | | |
| Crying participants | | | | |
| Non-suppressing (n = 5) | 0.6 (0.3) | -0.4 (0.4) | -0.1 (0.4) | 0.1 (0.2) |
| Suppressing (n = 23) | 0.7 (0.4) | -0.5 (0.2) | 0.1 (0.4) | -0.02 (0.2) |

## DISCUSSION

The main objective of the present study was to explore the effects of crying and inhibition of tears on mood and pain perception. We anticipated that crying would not influence the reported mood and pain perception, whereas the suppression of tears would have a negative effect on both mood and pain perception.

As in previous laboratory studies (see for a review Cornelius, 1997a, 2001), participants who cried during the emotionally arousing film felt worse afterwards as compared with before, but so did participants who did not cry. The suppression of tears failed to have a substantial influence on the reported mood. The only effect found was that participants who did not have the urge to cry (i.e.,

individuals who did not cry and did not suppress their tears) reported a smaller increase in negative mood than the other participants. These results are in line with a study of Gross (1998) on the influence of different forms of emotion regulation on emotional experience. In that study, participants who reappraised a disgusting film in such a way that they would feel no emotion (i.e., antecedent-focused emotion regulation) experienced less negative feelings than a control group, whereas participants who suppressed their expressive behavior (i.e., response-focused emotion regulation) experienced as much negative emotion as a control group. It can be postulated that the participants who did not have to urge to cry in the present study successfully reappraised the film and, therefore, did not experience as much negative mood as the other participants. The fact that participants who did not cry felt as worse as crying participants after the emotionally arousing film suggests that the non-crying participants mainly used response-focused emotion-regulation strategies. According to Gross (1998), the two forms of emotional regulation each have different consequences for psychological and physical well-being. Therefore, it is important in future research to take into account the different strategies people adopt to manage their emotional experience when faced with emotional events.

An alternative explanation of the found mood-effects is that the mood manipulation was not as successful for all participants. Possibly, the induction of a negative mood was less successful in individuals who did not have the urge to cry than in the individuals who did (Martin & Labott, 1991; Nyklícek, Vingerhoets, & Denollet, 2002). Extending this argument, it is plausible that the individuals who cried were more moved by the film than the individuals who had the tendency to cry but were able to suppress their tears. The finding that the reported negative mood after the film was not higher for the crying participants than for the participants who inhibited their tears might indicate that crying did partially neutralize the experienced distress, namely to the level of the participants who successfully suppressed their tears. Future research should therefore take into account how participants feel right before the moment they start to cry or have the tendency to cry but suppress their tears and then determine the effects of crying on mood.

Concerning pain perception, it appeared that watching the emotionally arousing film did not influence the sensory threshold or pain tolerance. The pain threshold only increased for the participants who did not cry during the film. In other words, in line with our expectations, crying during the emotionally arousing film hardly influenced the pain perception of participants, but, unexpectedly, suppressing one's tears also did not change the pain perception. In contrast, the results revealed that, across measurements, crying participants had a higher pain threshold and tolerance than non-crying participants, and participants who suppressed their tears had a lower pain threshold and tolerance than participants who did not suppress their tears. Most remarkably, participants who reportedly had

never suppressed their tears and had cried during the emotionally arousing film reported a much higher pain threshold and tolerance than the other participants. However, since this group only consisted of five individuals, no definitive conclusion can be drawn from these results.

In short, the present study revealed an association between crying behavior and pain perception. Vingerhoets et al. (2000) have suggested five models to explain a relationship between crying and well-being (read: pain perception). The first two models assume that crying, directly or indirectly, changes pain perception. According to the third model, the relationship between crying and pain perception might be a spurious one meaning that a third variable (e.g., personality factors or coping styles) influences both crying and pain perception. Furthermore, crying might only have effects on pain perception when a person is exposed to stressful conditions and experiences distress. Finally, their last model refers to the situation in which crying is determined by pain perception instead of the other way around. The findings of the present study revealed that, based on the crying behavior during the emotionally arousing film, groups of participants could be formed that already differed in pain perception at baseline. In other words, there was little evidence that crying is a determinant of pain perception. Because there were hardly any significant interactions between time point and pain perception, the model stating that crying buffers the effects of experiencing distress also does not seem plausible. Hence, most likely is that pain perception (as a more stable person characteristic) influences crying during watching a film or that a third variable is in play. Since Labott and Martin (1987) reported that crying during a sad film was associated with the general tendency to cry, it might be that the general tendency to cry and the general tendency to inhibit crying are related to pain perception. In other words, it can be speculated that the general tendency to express experienced distress via crying (as a feature of personality) results in both a higher chance to cry during a sad film and a better pain tolerance.

A second aim of the present study was to examine whether beliefs on crying influenced the self-reported mood-effects of crying. As anticipated and found in previous studies (see Cornelius, 1997a, 2001), participants indicated that they generally feel better after a crying episode while crying during watching the emotionally arousing film did not improve their mood. However, contrary to our expectations, four weeks after the film session crying participants indicated accurately that their mood did not change as a consequence of these particular tears. This suggest that implicit theories held by the participants did not bias the self-report of this particular crying episode in favor of the idea that crying is relieving. As pointed out by Cornelius (1997a), in previous retrospective studies participants could choose themselves on which crying episode they reported. Possibly, when asked about the general effects of crying or the effects of the most recent crying episode, people ignored these instructions and instead reported on crying episodes after which they felt better since this is expected. Another

explanation for the unexpected finding is that participants simply remembered the mood ratings they made during the film session and wanted to be consistent in their reports, thereby overruling the role of implicit theories.

A shortcoming of the present study is that we did not observe the crying behavior of the participants, and, therefore, had to rely on the participants' self-reports to determine whether they had cried or had inhibited their tears. However, since several studies have demonstrated that self-ratings of crying are quite accurate when compared with ratings of observers (Choti, Marston, Holston, & Hart, 1987; Kraemer & Hastrup, 1988; Marston, Hart, Hileman, & Faunce, 1984), there is little reason to assume that our methodology was not valid. In contrast, a limitation of our study is that the sample consisted of only female students. Research has consistently shown that women cry more often, more intensely and for a longer period than do men (Vingerhoets & Scheirs, 2000). As suggested by Martin, Guthrie, and Pitts (1993), crying may represent quite different psychological processes in males and females, which implicates that the effects of crying may be sex dependent. Replication in a male sample is additionally important because research has revealed sex differences in pain perception (e.g., Nyklícek et al., 1999; Weaver & Zillmann, 1994). Therefore, without further research in a male population, we cannot assert that a general high tendency to express distress by means of tears has positive effects on the pain perception of both men and women.

In sum, our hypothesis that crying facilitates the recovery of homeostasis via its short-term effects on mood and pain perception was not supported. There was only an indirect indication that crying partially neutralizes experienced distress. The present results did reveal a relationship between crying behavior during the film and pain perception in general (i.e., both before and after the film), which might most likely be explained by a third variable such as personality. Therefore, it is important that future studies determine whether the effects of crying on the crying person him/herself are associated with personality traits. More specifically, we hypothesize that a high general tendency to cry and not to suppress one's tears when experiencing distress might result in a better psychological and/or physical well-being (including a higher pain tolerance) in the long run. In addition, the possible social effects of crying should not be ignored. Several studies have shown that crying is a compelling communicative signal with a high potential to elicit empathy and emotional support of other people (Hendriks, Nelson, Cornelius, & Vingerhoets, submitted). It could very well be that crying fulfils both the recovery function and the communicative function, and should as such be considered a behavior that is important for human adaptation.

# CHAPTER 3
# The effects of crying on cardiovascular functioning*

## INTRODUCTION

Crying is a typically human emotional expression, which is very common in everyday life (Vingerhoets & Cornelius, 2001; Vingerhoets et al., 2000). It has been defined by Patel (1993, p. 206) as a 'complex secretomotor phenomenon characterized by the shedding of tears from the lacrimal apparatus, without any irritation of the ocular structures, and often accompanied by alterations in the muscles of facial expression, vocalizations, and in some cases, sobbing, which is the convulsive inhaling and exhaling of air with spasms of the respiratory and truncal muscle groups'. While many animals utter cries when in distress, humans appear to be the only species that shed tears (Vingerhoets & Cornelius, 2001). In spite of this, there has been much speculation and little scientific research on the phenomenon of adult crying. As a consequence, it is still unknown what function crying serves.

In the scientific literature, two possible functions of crying have been hypothesized (Gross et al., 1994; Vingerhoets et al., 2000). First, it has been proposed that crying is primarily designed to communicate the need for help and to stimulate others to offer this help and/or to provide comfort and emotional support (Frijda, 1997; Kottler, 1996; Nelson, 2000). Second, crying is expected to facilitate the recovery of psychological and physiological homeostasis after distress in the crying individual him/herself. One putative mechanism responsible for this effect is that crying decreases sympathetic nervous system activity (Gross et al., 1994). Several researchers (e.g., Bindra, 1972; Gross et al., 1994; Kraemer & Hastrup, 1988) have suggested that intense emotions lead to excessively high levels of sympathetic activity, which may be followed by a rebound of parasympathetic activation that serves to dampen this activity and to restore homeostasis. Even though the lacrimal gland, which is responsible for the production of tears, is innervated by both the parasympathetic and sympathetic nervous system, only the stimulation of parasympathetic fibers of the seventh cranial nerve results in an increase of tear secretion (Gross et al., 1994; Rottenberg et al., 2003; Van Haeringen, 2001). It has been proposed that tears are either the result of a temporary parasympathetic

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* The present study has been approved by the medical ethical committee of the TweeSteden Hospital in Tilburg, the Netherlands.

overcompensation (Bindra, 1972; Efran & Spangler, 1979; Gross et al., 1994) or, the other way around, might stimulate the activation of the parasympathetic nervous system (Rottenberg et al., 2003).

Until now, only a few empirical studies have examined the physiological concomitants of crying (Gross et al., 1994; Kraemer & Hastrup, 1988; Rottenberg, Gross, Wilhelm, Najmi, & Gotlib, 2002; Rottenberg et al., 2003; Sakuragi, Sugiyama, & Takeuchi, 2002). In all these studies, participants were exposed to a sad film that was aimed to elicit a crying response, and the difference between crying and non-crying participants in psychophysiological variables was examined. Kraemer and Hastrup (1988) demonstrated that crying and non-crying participants did not differ from each other in terms of heart rate and number of skin-conductance fluctuations at both a pre-film and post-film baseline measurement. Crying participants did have a higher heart rate just before crying than non-crying participants during the same time period. During the minute that crying participants began to cry, crying individuals had a higher heart rate and more skin-conductance fluctuations than non-crying individuals suggesting a higher physiological arousal.

Gross et al. (1994) investigated the effects of crying on a broad range of physiological variables. The statistical analyses revealed that crying had no influence on finger pulse amplitude and respiratory depth. Concerning skin conductance level, it appeared that crying individuals had greater increases from baseline both before and during crying than non-crying individuals. During the period of crying, crying participants additionally showed greater increases in heart rate, greater decreases in finger temperature and smaller decreases in respiratory period than non-crying participants. In other words, whereas the results for respiratory period were in accordance with the view that crying lowers physiological arousal, the results for heart rate and finger temperature revealed that crying was associated with increased physiological arousal.

In the study of Sakuragi et al. (2002), the cardiac sympathovagal balance (i.e., low frequency/high frequency amplitude-ratio of heart rate variability (HRV)) appeared to be significantly higher during the second half of a tragedy film than during baseline. The high-frequency component of HRV, which reflects cardiac parasympathetic nerve activity, was significantly lower during both the second half of the film and a post-film period than during baseline. However, in this study, all the participants cried more or less, and, therefore, no definitive conclusions can be drawn concerning the contribution of tears to these findings.

Rottenberg and colleagues (Rottenberg et al., 2002; Rottenberg et al., 2003) studied the physiological changes associated with crying in depressed and non-depressed individuals. Focusing on the results of the healthy individuals, Rottenberg et al. (2002) demonstrated that participants who cried had a higher heart rate and more skin conductance responses during the sad film than participants who did not cry. Whereas for crying participants the skin conductance level did not change from a neutral film to the sad film, non-crying participants

revealed a decrease in skin conductance level. These results suggest that crying is associated with greater physiological arousal than non-crying. In a more recent study of this group (Rottenberg et al., 2003), crying individuals exhibited higher levels of respiratory sinus arrhythmia during a postfilm period than during the neutral and sad film, while no such effects were found for non-crying individuals. In addition, crying participants demonstrated a greater cardiac acceleration during the sad film than non-crying participants. This difference was no longer present in the post-film period, but the heart rate of crying persons during this period was still higher than during the baseline period. On the basis of these findings, Rottenberg et al. (2003) concluded that crying led to an increase of parasympathetic activity (i.e., respiratory sinus arrhythmia), which partially counteracted the strong sympathetic drive to the heart.

In short, the studies on the physiological effects of crying suggest that tears are associated with an increase in physiological arousal. The study of Rottenberg et al. (2003) additionally indicated that this heightened arousal was counteracted by an increased activation of the parasympathetic branch of the autonomic nervous system, which might dampen the activity of the sympathetic nervous system. Unfortunately, Rottenberg et al. (2003) did not measure an indicator of sympathetic activation. Since physiological arousal reflects the net balance of parasympathetic and sympathetic nervous system activity, it would be highly valuable to measure the activation of both branches separately (De Geus & Van Doornen, 1996).

In order to obtain a better understanding of the functions of adult crying, the objective of the present study was to determine the influence of crying on physiological functioning. More specifically, the effects of crying on the activation of the sympathetic and parasympathetic branches of the autonomic nervous system were examined. Female participants watched a neutral film and an emotionally arousing film, and individuals were asked to press a button when they cried during the emotionally arousing film. Heart rate, respiration rate, blood pressure and skin conductance level were measured during both films as indices of physiological arousal. In order to determine the effects of crying on the activity of the sympathetic and parasympathetic nervous system, we additionally measured the pre-ejection period and respiratory sinus arrhythmia. Whereas the pre-ejection period is an index of cardiac contractility that has proven to be a reliable indicator of the sympathetic influence on the heart, the direct cardiorespiratory interaction that is reflected in respiratory sinus arrhythmia can be used to index the vagal tone of the heart (Cacioppo et al., 1994; De Geus & Van Doornen, 1996). We expected that crying would be associated with higher sympathetic activation, which is counteracted by an increased parasympathetic influence on the heart. Moreover, we aimed to determine whether crying is a cause or a result of this increased parasympathetic activation. We therefore measured the short-term changes in physiological functioning and examined which physiological changes precede and which follow the shedding of emotional tears.

## METHOD

### Participants

Sixty female psychology students of Tilburg University took part in the present study. Forty of them were first-year students, who received course credit for participation, and the remaining 20 students were second- or third-year students, who received a financial reward (30 euro) for participation. Data of six (two first-year) students had to be excluded due to equipment failure. The age of the final group varied from 18 until 32 years ($M$ = 20.4, $SD$ = 2.8). Exclusion criteria were the presence of any severe chronic physical or psychiatric illness, the use of medication other than hormonal contraceptives, and being pregnant.

### Film stimuli

A National-Geographic documentary entitled Natural Balance was used as neutral film (Nixon, 1994). This documentary lasted about 15 minutes and showed researchers who studied animals in their natural habitat. As for the emotionally arousing film, 'Once were warriors' (OWW; Scholes & Tamahori, 1994) was selected. This film depicts the life of a Maori family in New Zealand that is tyrannized by the father. It shows dramatic scenes of extreme violence, rape and suicide. Previous research revealed that female students experience strong emotional reactions while watching this film (Van Tilburg & Vingerhoets, 2002). For the present study, a selection of scenes of OWW was shown resulting in a film of about 70 minutes. Both films were displayed on a 70 cm (27.6 inch) television monitor placed approximately 3.30 m (10.8 ft) away from the participant. Sound was presented through a Dolby surround-system.

### Measurements

*Crying behavior during film OWW*

Participants were asked to press a button every time they cried while watching the film OWW. In the instructions, crying was referred to as anything from tears in one's eyes until running eyes and sobbing.

*Physiological variables*

The electrocardiograph (ECG) signal, the blood-pressure signal and electrodermal activity were digitized by an 12-bit AD-converter at 1000 Hz and stored for later off-line processing. The Ambulatory Monitoring System device (VU-AMS, Vrije Universiteit, Amsterdam, the Netherlands; Klaver, De Geus, & De Vries, 1994) was used to record the ECG and impedance cardiograph (ICG) signals for determining the respiration rate (RR), respiratory sinus arrhythmia (RSA) and pre-ejection period (PEP).

*Heart rate (HR).* The ECG signal was measured using three pregelled Ag/AgCl electrodes. The two measuring electrodes were placed 4 cm above the jugular notch of the sternum and at the apex of the heart over the ninth rib; the ground electrode was placed above the right iliac crest. A customized computer-program was used to identify the R-wave and inter-beat-intervals (IBIs) were calculated as the interval (in ms) between successive R-waves. These IBIs were transformed into a measure of HR, that is, the number of beats per minute.

*Diastolic blood pressure (DBP) and systolic blood pressure (SBP).* The blood-pressure signal was obtained with the Portapres device (Model-2, Finapres Medical Systems BV, Arnhem, the Netherlands), which provides a continuous measurement of finger arterial blood pressure on a beat-to-beat basis. The Portapres employs the arterial volume-clamp method of Peñáz (1973; Wesseling, 1990) in combination with the physiological calibration criteria for the proper unloading of the finger arteries developed by Wesseling and colleagues (Wesseling, De Wit, Van der Hoeven, Van Goudoever, & Settels, 1995). The finger cuff was placed on the middle phalanx of the right middle finger. A so-called height correction unit compensated hydrostatic pressure changes due to relatively slow movements of the hand. From the stored blood pressure signal, DBP and SBP were derived for each heartbeat as the minimum and maximum blood pressure. Both DBP and SBP were lacking for two persons due to equipment failure.

*Skin conductance level (SCL).* Electrodermal activity was recorded using a constant voltage (.5 V) coupler with two Ag/AgCl electrodes (contact area of 8 $mm^2$) placed on the thenar and hypothenar eminences of the palm of the right hand. The electrolyte medium contained a .05-M concentration of NaCl in Unibase. Due to equipment failure, SCL was absent for six participants.

*Respiration rate (RR), respiratory sinus arrhythmia (RSA) and pre-ejection period (PEP).* By means of six disposable pregelled Ag/AgCl electrodes, the ECG and ICG signals were recorded (see De Geus & Van Doornen, 1996 for an extended description). One electrode, placed 4 cm above the jugular notch of the sternum, was a combined ECG/ICG electrode. The other measuring ECG electrode was placed at the apex of the heart over the ninth rib and a ground electrode was placed above the right iliac crest. The second ICG measuring electrode was placed directly over the tip of the xiphoid process of the sternum. The two ICG current electrodes were placed at the back, at the base of the neck (C3/C4) and over vertebrae (T8/T9). DZ/dt values were sampled only during a short period (512 ms) around each R-wave and were ensemble averaged over a period of 30 seconds.

The VU-AMS software package was used to extract RR, RSA and PEP (see De Geus & Van Doornen, 1996 for an extended description). The starting points of inspiration and expiration were used to compute the average RR in breaths per minute. Using the respiratory intervals, RSA was computed for each breath using the peak-to-through method (De Geus & Van Doornen, 1996;

Grossman, Van Beek, & Wientjes, 1990). This means that the inspiratory minimal heart period was subtracted from the expiratory maximal heart period. Concerning PEP, the ensemble-averaged complexes of the dZ/dt signal were used to detect the B-point of the ICG signal. Next, the R-wave to B-point interval was computed and adding a fixed Q-R interval of 48 ms yielded the PEP. As a result of equipment failure, RR, RSA and PEP were missing for five individuals. RR and RSA could not be computed for two participants due to a noisy respiratory signal, and RSA was absent for one individual because of deviant IBIs.

**Procedure**

The present study was part of a larger project, which consisted of three separate sessions. In the first and last session, participants filled in some questionnaires. During the second session ('film session'), besides monitoring the physiological variables, mood and pain perception were measured before, in between and after the two films. The results of these variables fall outside the scope of this paper and will be published elsewhere.

After their entry, potential participants were screened regarding the exclusion criteria. If they did not meet any of these criteria, the students received detailed information about the procedures of the project and were given one week to think over their participation. Those who volunteered to participate subsequently signed informed consent and appointments were made for the three sessions.

The film session was an individual session that took place in a small, well-lit laboratory room. After having welcomed the participants, the researcher (MH) explained the procedure for the film session once again. Subsequently, participants were seated in a comfortable chair and the devices for measuring the psychophysiological variables were connected. Next, the participants watched the two films and the researcher instructed the participants to press a button every time they cried (i.e., at least felt their eyes becoming wet) during the emotionally arousing film. The neutral film was always shown before the emotionally arousing film in order to familiarize participants with the experimental setting and to obtain baseline values for the psychophysiological variables. During the films, participants could communicate with the researcher through an intercom. In the end, all the electrodes and transducers were removed and participants were thanked for their participation.

**Physiological data reduction**

All automatic scoring was verified by visual inspection and all signals were screened for artifacts and outliers. Subsequently, laboratory software computed averages of the physiological variables for the twelfth minute of the neutral film (i.e., baseline). For each participant who cried, we additionally determined the physiological reactivity for five continuous periods of 30 seconds defined by the onset of crying and by the timing of the ensemble averages of the impedance

cardiograph. Specifically, all five periods coincided with an ensemble average of the impedance cardiograph and the third period beheld the pressing of the button indicating the start of a crying episode. When a respondent pressed more than once, the physiological functioning during the first crying episode was selected for statistical analysis. Individuals who did not cry were randomly matched to individuals who did cry, and their physiological responses were partitioned into five periods equivalent to those of the crying participants with whom they had been matched. Subsequently, averages of the physiological variables were calculated and change scores were computed by subtracting the average of the baseline period from each of the five interval-averages.

## RESULTS

Twenty-seven (50.0%) of the 54 participants had at least once pressed the button during the film OWW. The non-crying and crying participants did not differ concerning age ($M$ = 20.2, $SD$ = 2.8 and $M$ = 20.6, $SD$ =2.8, respectively; $F$ = .33, $p$ = 57) or body-mass index ($M$ = 21.0, $SD$ = 2.9 and $M$ = 21.5, $SD$ =3.2, respectively; $F$ = .30, p = 59). The participants who had cried during the film OWW pressed the button for the first time after 13.24 to 68.47 minutes (modus = 53.34 minutes) of the onset of the film OWW. Most participants cried for the first time during the film fragment in which the mother of the Maori family finds her daughter, who hanged herself from a tree in the back yard.

### Physiological correlates of crying

A MANOVA was performed to determine whether the crying and non-crying participants differed in physiological arousal during the baseline period. Both the multivariate analysis on all the physiological variables ($F$(7, 32) = 0.85, $p$ = .55, *partial* $\eta^2$ = .16) and the univariate analyses on each physiological variable separately (all $F$(1, 38)s < 2.04, $p$s > .16, *partial* $\eta^2$s < .0) did not approach the level of significance. In other words, the two groups of participants revealed a comparable level of physiological arousal while watching the neutral film.

In order to assess the physiological effects of crying, a GLM repeated measure analysis on the change scores of all the physiological variables was performed with Time Period as a within-subjects factor and Crying as a between-subjects factor. The results of the univariate approach are reported, and the probability values were adjusted using the Greenhouse-Geisser procedure. This analysis revealed that the main effect of Crying was not significant ($F$(1, 36) = 2.68, $p$ = .11, *partial* $\eta^2$ = .07). The interaction effect of Time Period x Crying was significant ($F$(2.0, 71.7) = 3.94, $p$ < .05, *partial* $\eta^2$ = .10) and the main effect of Time Period approached the level of significance ($F$(2.0, 71.7) = 3.03, $p$ = .06, *partial* $\eta^2$ = .08). These results indicated that crying partially determined the physiological responses during watching the film OWW.

Subsequently, separate GLM repeated measures analyses were conducted on the change scores of each physiological variable with Time Period as a within-subjects factor and Crying as a between-subjects factor. Again, the univariate results with adjusted probability values are reported. Table 1 and Table 2 present the means and standard deviations for all physiological variables and time periods for non-crying and crying participants, respectively.

*Heart rate*

For HR, there was an effect of Crying ($F(1, 52) = 5.00$, $p < .05$, *partial* $\eta^2 = .09$). Whereas HR increased compared to baseline values for crying participants (*mean change* = 3.5, *SD* = 7.5), HR decreased compared to baseline values for non-crying participants (*mean change* = -0.5, *SD* = 5.5). In addition, the effect of Time Period significantly influenced HR ($F(2.9, 150.6) = 4.87$, $p < .01$, *partial* $\eta^2 = .09$). Post-hoc analyses revealed that the increase in HR was greater during Time Period 2 than during Time Period 4 and 5 (both $F(1, 53)$s $> 4.88$, $p$s $< .05$, *partial* $\eta^2$s $> .08$). Additionally, the increase in HR was greater during Time Period 3 than during Time Period 1, 4 and 5 (all $F(1, 53)$s $> 4.47$, $p$s $< .05$, *partial* $\eta^2$s $> .08$). In other words, across all participants, HR increased up till Time Period 3 and than started to decrease (see Figure 1). The mean change-scores indicate that crying was preceded by an increase and followed by a decrease in cardiac activity.

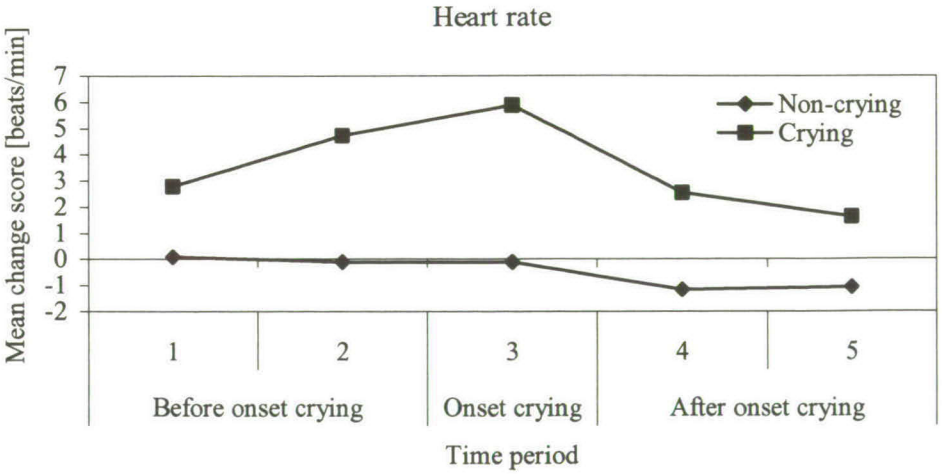


**Figure 1.** Mean change from baseline in heart rate as a function of crying

**Table 1.** Mean scores on the physiological variables (with standard deviations in parentheses) for non-crying participants (n = 27)

| Variable | Baseline | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 |
|---|---|---|---|---|---|---|
| HR | 70.0 (9.3) | 70.1 (8.7) | 69.9 (9.3) | 69.9 (8.9) | 68.9 (8.6) | 69.0 (8.5) |
| DBP | 52.7 (13.3) | 64.2 (11.7) | 65.0 (11.3) | 64.8 (11.4) | 64.6 (12.0) | 64.8 (11.2) |
| SBP | 118.6 (15.4) | 133.4 (17.0) | 133.4 (17.4) | 132.9 (16.2) | 133.1 (16.7) | 135.2 (15.8) |
| SCL | -1.2 (3.3) | 3.5 (4.9) | 3.6 (4.7) | 3.8 (4.5) | 3.7 (4.5) | 3.5 (4.1) |
| RR | 17.1 (2.1) | 16.9 (2.3) | 16.8 (2.5) | 16.9 (2.7) | 16.7 (2.1) | 17.0 (2.5) |
| RSA | 89.3 (56.0) | 81.1 (63.9) | 86.6 (78.7) | 87.5 (67.2) | 91.0 (56.2) | 84.3 (63.6) |
| PEP | 104.3 (23.3) | 101.4 (23.0) | 101.9 (22.3) | 102.8 (22.7) | 103.8 (23.0) | 103.2 (22.7) |

*Note*. HR = heart rate in beats/min, DBP = diastolic blood pressure in mmHg, SBP = systolic blood pressure in mmHg, SCL = skin conductance level in μS, RR = respiration rate in breaths/min, RSA = respiratory sinus arrhythmia in ms, PEP = pre-ejection period in ms.

**Table 2.** Mean scores on the physiological variables (with standard deviations in parentheses) for crying participants (n = 27)

| Variable | Baseline | Period 1 | Period 2 | Period 3 | Period 4 | Period 5 |
|---|---|---|---|---|---|---|
| HR | 67.7 (8.3) | 70.5 (8.5) | 72.4 (9.2) | 73.6 (9.2) | 70.3 (7.5) | 69.4 (7.8) |
| DBP | 52.6 (9.3) | 66.6 (9.6) | 68.6 (11.6) | 69.0 (10.9) | 69.3 (12.1) | 69.3 (11.2) |
| SBP | 115.3 (13.2) | 137.1 (16.0) | 138.5 (18.5) | 139.2 (19.1) | 139.1 (20.5) | 139.7 (18.8) |
| SCL | -1.0 (4.7) | 5.0 (5.1) | 5.0 (5.2) | 5.5 (5.0) | 5.7 (5.2) | 5.3 (4.6) |
| RR | 16.6 (2.1) | 16.9 (2.8) | 16.1 (3.2) | 15.1 (2.0) | 15.1 (2.3) | 14.9 (3.3) |
| RSA | 97.7 (45.7) | 88.0 (36.1) | 97.7 (44.8) | 123.8 (50.0) | 114.5 (60.6) | 127.5 (95.6) |
| PEP | 105.8 (18.1) | 105.0 (17.5) | 105.1 (17.9) | 106.5 (18.6) | 106.1 (18.9) | 106.9 (18.6) |

*Note*. HR = heart rate in beats/min, DBP = diastolic blood pressure in mmHg, SBP = systolic blood pressure in mmHg, SCL = skin conductance level in μS, RR = respiration rate in breaths/min, RSA = respiratory sinus arrhythmia in ms, PEP = pre-ejection period in ms.

*Diastolic blood pressure*

DBP changed significantly over Time Periods ($F(2.7, 137.4) = 3.53$, $p < .05$, *partial* $\eta^2 = .07$). Follow-up analyses demonstrated that the increase in DBP from baseline was smaller for Time Period 1 than for the other Time Periods (all $F(1, 51)$s > 4.70, $ps < .05$, *partial* $\eta^2$s > .08). The mean change-scores revealed that for both groups DBP increased from Time Period 1 to Time Period 2 and then stabilized (see Figure 2). This implies that there was an increase in physiological arousal in both groups independent of crying.

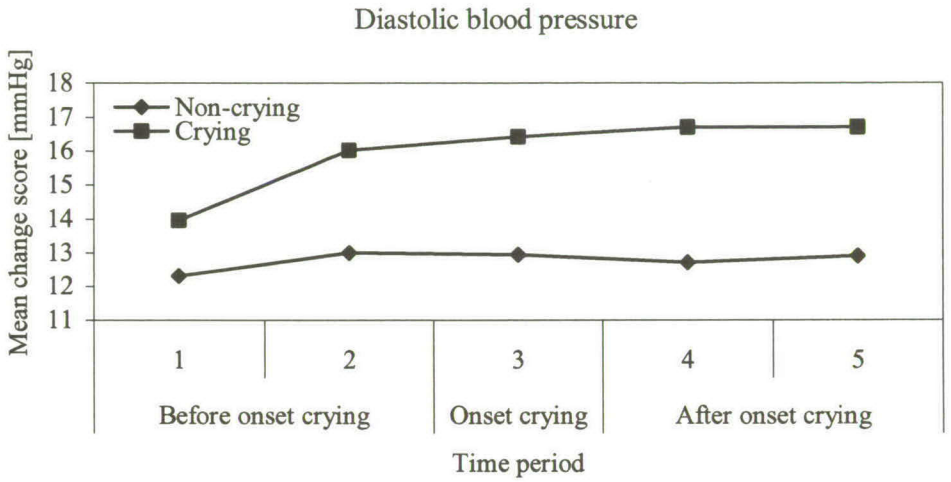


**Figure 2.** Mean change from baseline in diastolic blood pressure as a function of crying

*Systolic blood pressure*

Concerning SBP, none of the effects reached the level of significance (all $F$s < 2.75, $ps > .10$, *partial* $\eta^2$s < .05). The SBP was thus not affected by crying.

*Skin conductance level*

SCL was not influenced by Crying, Time Period or Time Period x Crying (all $F$s < 1.79, $ps > .17$, *partial* $\eta^2$s < .04) indicating a lack of influence of crying on this particular index of physiological arousal.

*Respiration rate*

The effects of Time Period ($F(3.4, 146.1) = 2.99$, $p < .05$, *partial* $\eta^2 = .07$) and of Time Period x Crying ($F(3.4, 146.1) = 2.67$, $p < .05$, *partial* $\eta^2 = .06$) significantly influenced RR. To further examine the interaction effect, we performed repeated

measures analyses for non-crying and crying individuals separately with Time Period as a within-subjects factor. It appeared that RR changed over time for crying participants ($F(3.2, 66.3) = 3.65$, $p < .05$, *partial* $\eta^2 = .15$), but not for non-crying participants ($F(3.1, 68.3) = 0.23$, $p = .88$, *partial* $\eta^2 = .01$). For the crying individuals, RR increased compared to baseline in Time Period 1, but decreased compared to baseline in the other Time Periods (all $F(1, 21)$s $> 5.21$, $p$s $< .05$, *partial* $\eta^2$s $> .20$). Figure 3 shows that crying was associated with a decrease in RR from Time Period 1 to Time Period 3, after which RR remained constant. Assuming that a faster RR indicates a greater physiological arousal (Gross et al., 1994), these results suggest that crying was preceded by a decrease in arousal.

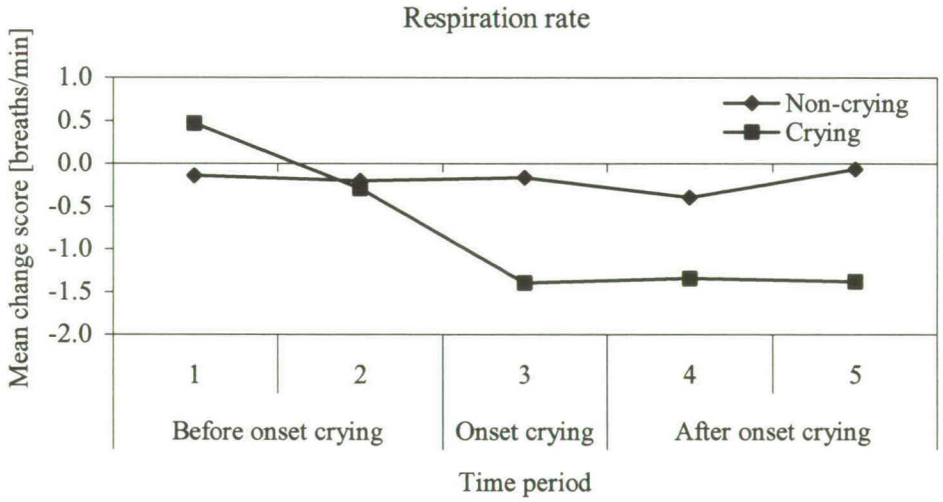


**Figure 3.** Mean change from baseline in respiration rate as a function of crying

*Respiratory sinus arrhythmia*

RSA was significantly influenced by Time Period ($F(2.2, 91.8) = 3.52$, $p < .05$, *partial* $\eta^2 = .08$). The interaction Time Period x Crying approached the level of significance ($F(2.2, 91.8) = 2.51$, $p = .08$, *partial* $\eta^2 = .06$). In order to get a better insight into this near-significant interaction, repeated measures analyses were performed for each level of Crying separately with Time Period as a within-subjects factor. It appeared that the effect of Time Period was not significant for the participants who did not cry ($F(2.9, 63.9) = 0.72$, $p = .54$, *partial* $\eta^2 = .03$). For the participants who did cry, the concerning interaction approached significance, ($F(2.0, 39.4) = 3.2$, $p = .05$, *partial* $\eta^2 = .14$). Post-hoc analyses revealed an increase in RSA compared to baseline in Time Period 3, but a decrease in Time

Period 1 and 2 (both $F(1, 20)$s > 7.82, $p$s < .05, *partial* $\eta^2$s > .28). Likewise, in Time Period 4, RSA increased compared to baseline, but in Time Period 1 it decreased compared to baseline ($F(1, 20) = 6.43$, $p < .05$, *partial* $\eta^2 = .24$). The mean change-scores demonstrated that RSA increased up till Time Period 3, and then remained high (see Figure 4). These data imply that crying was preceded by an increase in vagal tone to the heart.

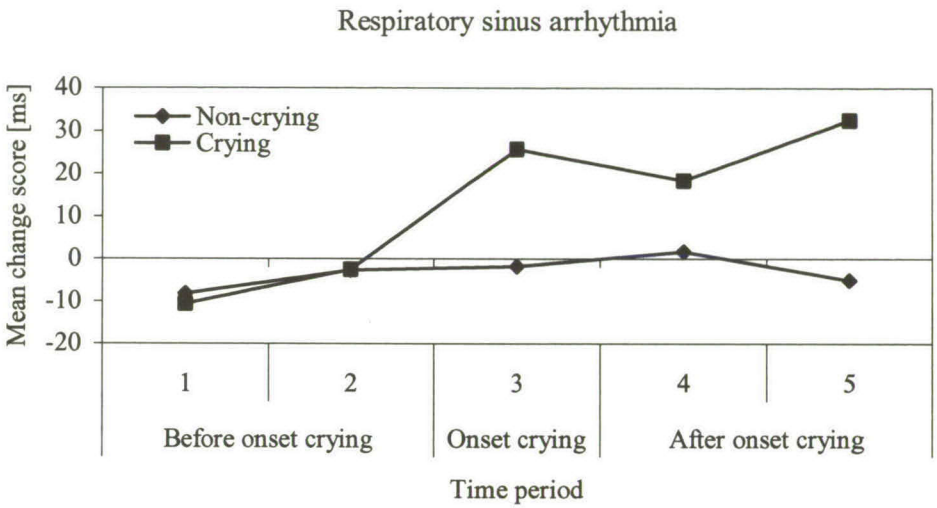


**Figure 4.** Mean change from baseline in respiratory sinus arrhythmia as a function from crying

*Pre-ejection period*

Concerning PEP, there was an effect of Time Period ($F(3.4, 153.0) = 4.20$, $p < .01$, *partial* $\eta^2 = .09$). The post-hoc analyses revealed that during Time Period 1 participants showed a greater decrease in PEP than during Time Period 3, 4 and 5 (all $F(1, 46)$s > 8.78, $p$s < .01, *partial* $\eta^2$s > .16). During Time Period 2 the individuals demonstrated a greater decrease in PEP than during Time Period 3 and 4 (both $F(1, 46)$s > 4.20, $p$s < .05, *partial* $\eta^2$s > .08). In other words, PEP increased from Time Period 1 to Time Period 3 after which it stabilized (see Figure 5). The PEP results suggest an increase in the sympathetic drive to the heart for both crying and non-crying participants.

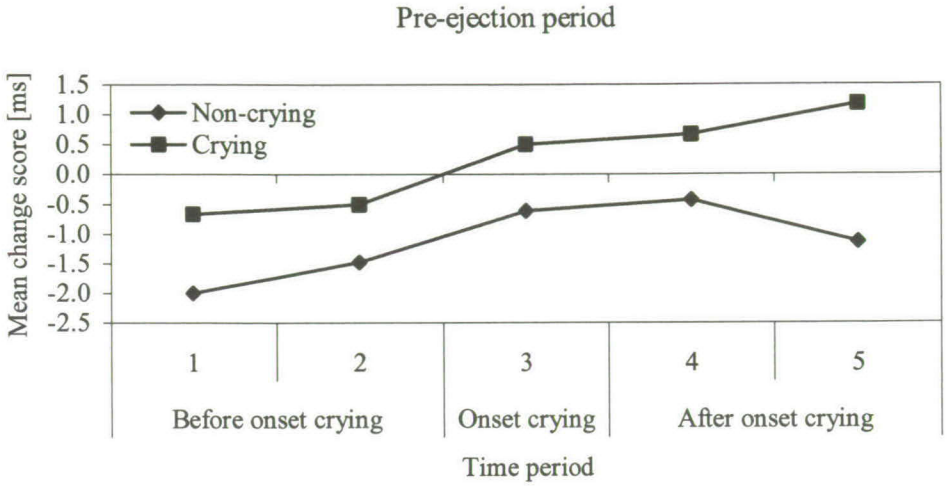


**Figure 5.** Mean change from baseline in pre-ejection period as a function of crying

*Respiratory sinus arrhythmia corrected for respiration rate*

RSA only accurately reflects the parasympathetic drive to the heart if respiratory parameters are held constant or are statistically controlled for (De Geus & Van Doornen, 1996; Grossman & Kollai, 1993). In order to examine whether variations in RR might account for the found changes in RSA, we performed MANOVA repeated measures analysis on RSA for non-crying and crying individuals separately with Time Period as within-subjects factor and RR as changing covariate. As for non-crying participants, RR significantly adjusted the effect of Time Period ($t$ = -2.14, $p < .05$, *partial* $\eta^2$ = .18), but the effect Time Period remained non-significant ($F(4, 87) = 0.59$, $p = .67$, *partial* $\eta^2$ = .03). Concerning the crying participants, RR tended to have an influence on the effect of Time Period ($t$ = -2.00, $p = .06$, *partial* $\eta^2$ = .17), and the effect Time Period no longer significantly influenced RSA ($F(4, 79) = 1.18$, $p = .33$, *partial* $\eta^2$ = .06). These data suggest that the found increase in RSA just before crying had to be partially attributed to changes in RR.

## DISCUSSION

The objective of the present study was to obtain a better insight into the nature of the physiological changes associated with crying. More specifically, we aimed to determine whether the shedding of emotional tears resulted in a parasympathetic rebound mechanism, which dampens heightened sympathetic activation. The present study extended the existing knowledge of the physiological effects of crying (1) by

measuring both respiratory sinus arrhythmia and the pre-ejection period as indexes of parasympathetic and sympathetic activation, respectively, and (2) by examining in more detail which physiological effects precede and which follow the act of crying.

In correspondence with previous studies (Gross et al., 1994; Kraemer & Hastrup, 1988; Rottenberg et al., 2002; Rottenberg et al., 2003), the present results revealed that crying while watching an emotionally arousing film was associated with an increased physiological arousal. More specifically, crying participants demonstrated an increase in heart rate, diastolic blood pressure and pre-ejection period just before they started to cry. However, non-crying participants showed a similar increase in diastolic blood pressure and pre-ejection period. Crying was additionally preceded by an increase in respiratory sinus arrhythmia and a decrease in respiration rate. Following crying, heart rate began to drop again. For both crying and non-crying participants, systolic blood pressure and skin conductance level did not change while watching emotionally arousing scenes.

Corroborating Rottenberg et al.'s (2003) findings, the present study revealed the existence of a parasympathetic rebound mechanism dampening the increased heart rate in crying participants. The cardiac acceleration before crying coincided with the increase in respiratory sinus arrhythmia, which subsequently resulted in a decreased heart rate following crying. Contrary to our expectations, crying failed to influence the pre-ejection period. These findings suggest that crying facilitates the maintenance of physiological homeostasis. However, the increased vagal tone did not reduce the force of the sympathetic drive to the heart, but only, at best, neutralized that influence. Because Rottenberg et al. (2003) did not measure the pre-ejection period or another index of sympathetic activation, this underlying pattern could not be revealed in their study. The present study therefore emphasizes the importance of measuring indices of the activity of both the sympathetic and the parasympathetic nervous system.

In short, the present study and the study of Rottenberg et al. (2003) both suggest that crying is associated with a parasympathetic rebound mechanism and thus that crying might serve a homeostatic function. However, before any definitive conclusions can be drawn, it is important to determine the precise contribution of crying to this rebound mechanism. It could be that emotional tears instigate this mechanism or that they are just the result of the mechanism. Rottenberg et al. (2003) compared the physiological arousal at three different time-intervals (i.e., baseline, emotionally arousing film and postfilm) without taking into account the onset of the crying episode. Therefore, they could not determine whether the parasympathetic rebound mechanism started before of after the onset of crying. An asset of the present study is that we looked in more detail at the changes in the physiological parameters just preceding and following the onset of a crying episode. It appeared that respiratory sinus arrhythmia mainly increased up to the beginning of the crying episode and then stabilized. This suggests that tears are more likely the result than the cause of the parasympathetic compensation (e.g., Bindra, 1972; Efran & Spangler,

1979; Gross et al., 1994). The question now remains whether crying is a necessary part that additionally facilitates this homeostatic mechanism or whether it is just an epiphenomenon.

It should be reminded that the changes in respiratory sinus arrhythmia were partially caused by variations in respiration rate. The results revealed that crying was preceded by a decreased respiration rate and that controlling for this drop in respiration reduced the changes in respiratory sinus arrhythmia associated with crying. Looking at the data on an individual level, we noticed that crying had a major impact on the respiration signal. This makes perfectly good sense given that crying is often accompanied by sobbing, that is, the convulsive inhaling and exhaling of air with spasms of the respiratory muscle groups (Patel, 1993). Therefore, it is important that future research examines how reliable respiration and, consequently, respiratory sinus arrhythmia, can be measured while a person is crying.

An important question is whether non-crying individuals in the present study did or did not have the tendency to cry and refrained from shedding tears, that is, to what extent suppression of crying played any role. Possibly, the found differences between crying and non-crying individuals in the present study result from the application of suppression by the non-crying participants rather than from the occurrence of crying in the crying participants. There exists strong evidence that the active inhibition of emotional expression requires physiological effort (Berry & Pennebaker, 1993; Gross & Levenson, 1993; Vingerhoets & Scheirs, 2001), which may interfere with the recovery of psychological and physiological balance. Accordingly, Gross and colleagues (Gross, 1998; Gross & Levenson, 1993, 1997) have demonstrated that the active inhibition of emotional expressive behavior (i.e., response-focused emotion regulation) results in an increased activation of the sympathetic nervous system, whereas reappraisal of the meaning of an emotional event (i.e., antecedent-focused emotion regulation) did not affect physiological functioning. Unfortunately, no previous study has questioned why non-crying participants did not shed tears, and thus research so far has not specifically focused on the effects of the inhibition of crying on physiological parameters. While Kraemer and Hastrup (1988) and Labott and Teleha (1996) instructed participants to express or inhibit their crying in response to a sad film, they only selected the participants who adhered to the instructions for statistical analyses without checking whether the non-crying individuals in the inhibition condition had the urge to cry at any time. As pointed out by Berry and Pennebaker (1993), low expressivity may not necessarily be the same as high suppression. In order to disentangle the physiological correlates of the shedding of and the active refraining from emotional tears, future research should not only measure if and when an individual cries but also if and when a person suppresses his/her tears.

A common idea, especially in the popular press and clinical literature, is that crying positively influences one's health (Cornelius, 1986, April; Vingerhoets & Scheirs, 2001). According to Vingerhoets et al. (2000) and to Vingerhoets and

Scheirs (2001), there exist two major ways to empirically explore the relationship between the shedding of emotional tears and health: (1) by performing studies which focus on the immediate psychobiological effects of crying or (2) by performing studies that address the relationship between crying frequency or proneness as a more stable personality feature and health status. The findings of the present study provide useful information concerning the first line of research. Since the findings revealed that crying was mostly the result of rather than the cause of increased parasympathetic activation, it has to be concluded that crying does not by definition facilitates recovery after being emotionally aroused and thus is healthy. However, the present results do not exclude the possibility that the shedding of emotional tears reinforces the parasympathetic rebound mechanism, or that the active suppression of crying has a negative influence on physiological recovery.

A shortcoming of the present study is that we did not observe the crying behavior of the participants, and, therefore, had to rely on the participants' self-reports to determine whether they had cried. However, since several studies have demonstrated that self-ratings of crying are quite accurate when compared with ratings of observers (Choti et al., 1987; Kraemer & Hastrup, 1988; Marston et al., 1984), there is little reason to assume that our methodology was not valid. In contrast, an important limitation is that our sample and those of most other studies (Gross et al., 1994; Kraemer & Hastrup, 1988; Rottenberg et al., 2003; Sakuragi et al., 2002) consisted of only women. Research has consistently shown that women cry more often, more intensely and for a longer period than do men (Vingerhoets & Scheirs, 2000). As suggested by Martin et al. (1993), crying may represent quite different psychological processes in males and females implicating that its effects may also be sex dependent. Replication in a male sample is further important because research has revealed sex differences in physiological responses to sad film-fragments (Fredrickson, Levenson, & Cartensen, 1992, October). Only the study of Rottenberg et al. (2002) included men as participants, but they did not report on any sex differences. Without further research in a male population, it cannot be concluded that crying is associated with an increased vagal tone to the heart in both men and women.

In sum, our hypothesis that crying is associated with a vagal rebound mechanism dampening the sympathetic drive to the heart in response to an emotional event was partially supported. While crying did not reduce the sympathetic drive to the heart, it was associated with an increase in the parasympathetic drive resulting in a decreased heart rate. However, crying only appeared to be an indicator of this increase in parasympathetic activation. It remains to be seen whether crying is a necessary part of this rebound mechanism and thus serves a homeostatic function. Future research should therefore pay more attention to the physiological effects of different mechanisms behind non-crying (including the active suppression of tears). Finally, the possible social effects of crying should not be ignored. Several studies have shown that crying is a

compelling communicative signal with a high potential to elicit empathy and emotional support of other people (Hendriks, Nelson et al., submitted). It could very well be that crying fulfils both a homeostatic function and a communicative function, and should as such be considered a behavior that from an evolutionary point of view is very important for human adaptation.

# PART II
# INTERPERSONAL CONSEQUENCES

# CHAPTER 4
# Social reactions to adult crying: The help-soliciting function of tears

## INTRODUCTION

Crying is one of the most compelling and certainly one of the most pervasive forms of human emotional expression (Cornelius, 1982). Defined as the secretion of tears associated with the experience of emotion (Cornelius, 1997b), crying is thought to be unique to human beings (Bindra, 1972; Vingerhoets et al., 2000). However, it is still largely unknown why adults cry and what purposes their crying serves. In order to get a better insight into the functions of adult crying, the present study was a first more systematic exploration of its effects on the social environment.

In the scientific literature, two possible functions of crying have been distinguished (Gross et al., 1994; Vingerhoets et al., 2000). First, crying may facilitate emotional catharsis and may speed up recovery after physiological arousal. Second, it has been proposed that crying is primarily designed to communicate to others in an unambiguous way that one is vulnerable, suffering and in need of help (Fridlund, 1992; Frijda, 1997; Yik & Russell, 1999). According to this latter view, the main function of crying may be to beckon others to help remove a given source of discomfort, and to elicit attention, empathy and support (e.g., Frijda, 1997; Kottler & Montgomery, 2001; Vingerhoets et al., 2000). Kottler (1996) speculated that crying is uniquely human because human newborns develop relatively slow and therefore for a considerably long time need the help of others to take care of them. As such, crying can be regarded as an attachment behavior (Cornelius & Lubliner, 2003; Nelson, 1998, 2000), and attachment research has indeed shown that crying is an inborn behavior that functions throughout life to call for and assure the protective and nurturing presence of caregivers (Bell & Ainsworth, 1972; Bowlby, 1969; Cassidy, 1999; Zeifman, 2001). In addition, crying has been hypothesized to signal the message to back off and to inhibit aggressive impulses of potential aggressors (Kottler & Montgomery, 2001).

Several studies have examined the social reactions to crying. The emphasis in these studies was on behavioral reactions, experienced emotions and/or on person perception. Cornelius and colleagues (Cornelius & Lubliner, 2003; Cornelius, Nussbaum, Warner, & Moeller, 2000), for instance, demonstrated that crying people were believed to communicate the message that they want help, comfort or to be taken care of. In addition, crying individuals have been reported to

be rated as more depressed, emotional and sad than non-crying individuals (Cornelius et al., 2000; Hendriks & Vingerhoets, submitted; Labott, Martin, Eason, & Berkey, 1991), and as eliciting more feelings of sadness in observers than individuals with neutral, anger or fear faces (Hendriks & Vingerhoets, submitted). When participants had to indicate how they respond to a crying person or how others react to their crying, it appeared that a crying person was generally offered comfort, attention and sympathy (Cornelius, 1982; Cornelius & Lubliner, 2003; Hendriks & Vingerhoets, submitted; Hill & Martin, 1997; Wagner et al., 1997). Individuals also tended to cry along with a crying person (Cornelius, 1982; Hill & Martin, 1997). Wagner et al. (1997), however, showed that a fifth of the medical students who cried at work were ridiculed, screamed at or looked at with contempt.

Concerning sex differences in reactions to crying, the studies of Jesser (1989) and of Cretser, Lombardo, Lombardo, and Mathis (1982) both revealed that respondents were more inclined to provide comfort and help to and to sympathize with a crying woman than to/with a crying man. It was further demonstrated that female participants more than male participants responded favorably to a crying person (Cretser et al., 1982; Jesser, 1989). More male than female respondents reported feeling confused or irritated in the presence of a crying person (Jesser, 1989), and female participants had more sympathy for a crying person than did male participants (Cretser et al., 1982). Labott et al. (1991), however, demonstrated that men were liked more when they cried and women when they displayed no emotional reaction. In contrast, in the studies of Cornelius and colleagues (Cornelius & Lubliner, 2003; Cornelius et al., 2000) and of Hendriks and Vingerhoets (submitted), the sex of the respondent and of the crying person did not substantially influence the social reactions to crying.

Sex role stereotypes might affect the appraisal of and reactions toward crying men versus crying women (Labott et al., 1991; Zillmann, Weaver, Mundorf, & Aust, 1986). One of the most pervasive stereotypes is still that of the crying woman alongside the man who knows how to control his feelings and to suppress his tears (Bekker & Vingerhoets, 2001). This might explain why a crying man generally met more negative consequences than a crying woman. In addition, some studies (Cretser et al., 1982; Jesser, 1989; Labott et al., 1991) revealed that male and female respondents reacted differently to a crying person. As suggested by Hendriks, Nelson et al. (submitted) and by Kennedy-Moore and Watson (1999), women might react with sympathy and support and men with irritation and confusion to a crying person, because women are more comfortable with intimacy and a nurturing role and therefore experience less feelings of awkwardness and desperation in the presence of a crying person than men.

In short, the empirical studies suggest that crying has a major impact on the social environment. The shedding of emotional tears partially determined how a crying person is perceived and how other people feel and react toward a crying person. Moreover, the results of the previous studies confirmed that crying mainly

communicates the need for help, and that it stimulates others to offer this help and support. However, evidence was also found that crying evokes negative reactions from the social environment. These differential social reactions seemed to partially depend on the sex of both the crying person and the respondent.

Other factors that might influence how individuals respond to a crying person are the valence of the situation and the relationship with the crying person. In emotion research, valence is considered an important dimension exceeding the distinction between specific moods or emotional states (Lang, Bradley, & Cuthbert, 1998; Scherer, 2000). The dimension of valence allows one to distinguish between positive and negative emotions and reflects the two accompanying behavioral orientations of approach and avoidance, respectively (Lang et al., 1998; Scherer, 2000). In crying research, the distinction between positive and negative is also encountered. The common denominator of adult crying is the perception of real or threatened separation or loss (Nelson, 1979, 1998, 2000) and helplessness (Vingerhoets et al., 2001; Vingerhoets, Van Geleuken, Van Tilburg, & Van Heck, 1997). It has been shown that the prototypical negative situations in which adults cry are the death of a close loved one and the dissolution of or conflict within romantic relationships (Nelson, 1998, 2000; Vingerhoets et al., 2000). Weddings, and reunions are positive situations in which people most often report crying. In these situations, happy outcomes are combined with losses that have been averted, outlived or overcome. Correspondingly, crying may be an expression of negative emotions such as sadness, anger, fear or of positive emotions such as joy and happiness (Vingerhoets et al., 2001; Vingerhoets et al., 2000). Therefore, it is important to take into account the valence of the situation in which a person cries as it can be expected that people more likely avoid a crying person in negative situations and approach a crying person in positive situations.

Concerning the relationship with another person, attachment theory suggests that crying is mainly designed to elicit care-taking behavior from intimate others (Bowlby, 1969). Accordingly, research has shown that people most likely cry in the presence of someone with whom they share a close relationship (Cornelius, 1981), or at home where intimates may be expected to be present (Vingerhoets et al., 2000; Vingerhoets et al., 1997). The study by Cornelius and Lubliner (2003) revealed that male participants were more likely to report leaving a crying person alone *only* if they did not know the person. In other words, it can be postulated that people respond more favorably toward a crying person when this person is a friend rather than a stranger.

In the present study, a vignette questionnaire was developed to obtain more systematic data concerning the social reactions to crying. The aim was to determine what the main effects of crying were on how a person is perceived, on how others feel and on how others respond to a person. Moreover, besides examining the possible moderating effects of the sex of the crying person and of the respondent, the present study was the first to explore the moderating influences of the

relationship with a person and the valence of the situation on the social reactions to crying.

Following the proposed communicative function of crying (Vingerhoets et al., 2000) and the results of the above summarized studies, it was hypothesized that a crying person would be judged more emotional than a non-crying person, that individuals would experience more sadness in the presence of a crying than a non-crying person, and that a crying person would elicit more help, attention and comforting behavior than a non-crying person. Concerning the moderating variables, we expected that the crying of men would evoke more negative responses than the crying of women, that female respondents would respond more favorable toward a crying person than male respondents, that crying in negative situations would have more negative consequences than crying in positive situations, and that the crying of a friend would evoke more positive reactions than the crying of a stranger.

## METHOD

### Participants

Five hundred and thirty individuals took part in the present study by completing a questionnaire (response rate of 71.7%). 58 first-year psychology students participated in partial fulfillment of a course requirement, and 472 volunteers reacted to announcements in local and national newspapers and magazines requesting respondents for research on crying. The sample consisted of 139 men aged from 18 up to 84 years ($M$ = 47.1; $SD$ = 15.8), and of 389 women aged from 17 up to 79 years ($M$ = 42.0; $SD$ = 16.3). Of two respondents the sex was unknown. 95% of the sample had the Dutch nationality. Most respondents were married/living together (53.6%) or were single (34.5%). 7.1% of the respondents was divorced/separated and 4.8% was widow/widower. 84.8% of the participants had a degree in secondary school or higher.

### Questionnaire and design

Based on descriptions of real-life crying episodes obtained in a previous study (Vingerhoets et al., 1997), six vignettes (see the Appendix) were written. Three vignettes described a negative situation (talking to someone at a funeral, causing a car crash and watching someone drop an expensive vase) and the other three described a positive situation (awarding a colleague, meeting someone who won a prize in a lottery and meeting someone who has become a parent). In each situation, the main character (i.e., the respondent) encountered another person who either cried or did not cry (the so-called crying status). The sex of the (non-)crying person and the relationship with the (non-)crying person (i.e., a stranger or a friend) were additionally varied. These eight different versions of each vignette were systematically distributed over different versions of the questionnaire. Moreover, there were two counterbalanced sequences of the vignettes to control for order effects

resulting in sixteen different versions of the questionnaire. Each version was filled in by 29 up to 36 respondents, by 6 up to 11 men and by 21 up to 27 women.

*Dependent variables*

*Person perception.* The respondents were asked the following question: 'What do you think of the other person?' Response alternatives were the following seventeen adjectives, each of which had to be rated on a 4-point scale varying from 'not at all' to 'very much': strange, manipulative, good, emotional, insecure, feminine, stable, inadequate, clever, squeamish, nice, masculine, unstable, stupid, friendly, normal and bad.

*Experienced emotions.* The respondents further had to indicate how they themselves would feel in each situation by answering the following question: 'How do you feel in this situation?' The following fourteen state indicators had to be rated on a 4-point scale varying from 'not at all' to 'very much': tense, astonished, sad, normal, at ease, involved, pleasant, uncomfortable, strange, happy, angry, cheerful, unpleasant and relaxed.

*Overt behavior.* The respondents had to answer the following question: 'What do you do in this situation? How do you react to the other person?' The following eleven options, each of which had to be rated on a 4-point scale varying from 'certainly not' to 'certainly so', were presented: I try to comfort him/her, I am happy for him/her, I pay attention to him/her, I help him/her, I try to calm him/her down, I get angry with him/her, I have sympathy for him/her, I do nothing, I am polite towards him/her, I talk to him/her, and I ignore him/her.

**Procedure**

The different versions of the questionnaire were randomly distributed among the respondents while trying to control for the number of men and women that filled in each version. The psychology students completed the questionnaire in a classroom setting, whereas the volunteers received the questionnaire by mail and filled it in at home. The participants were instructed to read each situation carefully and to imagine that they are the main character in the described situations. After reading each vignette, respondents were asked to report how they would react (to the (non-)crying person) in the situation, how they would judge the (non-)crying person and how they would feel in the situation.

**Statistical analyses**

The two participants of whom the sex was unknown were coded as a woman. Additionally, all the missing data (0.30%) were replaced with the group mean of the particular variable. In order to reduce the number of dependent variables, exploratory factor analyses were conducted on the three sets of dependent variables separately. The factor analyses were carried out on the matrix containing the item correlations computed over all combinations of subjects and situations. In other

words, a total of 530 × 6 = 3180 observations were available to compute the correlation between any two items in a scale. Three different decision criteria were used to determine the number of factors, namely Kaiser's rule, Cattell's scree plot, and parallel analysis (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Subsequently, a principal axis factoring was carried out for each set of dependent variables, and the resulting solutions were orthogonally rotated by means of the VARIMAX procedure with Kaiser Normalization implemented.

In order to determine the social reactions to crying, multilevel regression analyses were performed on Bartlett factor scores. One advantage of the use of Bartlett factor scores as dependent variables is that they enable a consistent estimation of the true regression coefficients (Croon, 2002; Skrondal & Laake, 2001). We chose for multilevel analyses because these kind of analyses allow for a correlation between responses given by the same participant in an experimental design where the level of the independent variables (for instance, sex of the (non-)crying person) change per measurement point, that is, per vignette (Snijders & Bosker, 1999). Dummy variables were used as predictors thereby making the regression analyses equivalent to a repeated measures ANOVA (Stevens, 1996). The following variables were inserted as possible predictors in the regression model: crying status, sex of the respondent, sex of the other (non)-crying person, relationship with the other person, valence of the situation, the interactions of each of the latter four variables with crying status, the interaction sex of the respondent x sex of the other person, and the interaction crying status x sex of the respondent x sex of the other person.

## RESULTS

### Factor analyses

*Person perception*

In the factor analysis three factors appeared, which together explained 48.1% of the total variance. Factor 1, accounting for 23.0% of the variance, was defined by high loadings on the items stupid (0.74), squeamish (0.71), bad (0.69), inadequate (0.63), manipulative (0.61) and strange (0.58), and was therefore referred to as Negative Characteristics. Factor 2 was labeled Positive Characteristics, since the items nice (0.74), friendly (0.73), good (0.69), stable (0.65) and clever (0.55) had high loadings on this factor. This factor explained 18.8% of the variance. Factor 3, referred to as Emotionality, explained an additional 6.3% of the variance. The items emotional (0.50) and feminine (0.46) mainly defined this factor.

*Experienced emotions*

Factor analysis yielded three common factors, which together explained 62.2% of the variance. Factor 1, called Negative Feelings, was mainly defined by the items uncomfortable (0.76), tense (0.73), strange (0.71), at ease (-0.71), unpleasant (0.71), normal (-0.64), angry (0.62) and astonished (0.51). The factor explained

32.9% of the total variance. The second factor was labeled Positive Feelings and explained 25.0% of the variance. The items cheerful (0.87), happy (0.85), and pleasant (0.77) had high loadings on this factor. Factor 3, accounting for another 4.3% of the variance, was called Sympathy in view of the fact that only the item involved (0.49) had a high loading on this factor.

*Overt behavior*

Factor analysis also yielded three factors for the items measuring overt behavior, which together explained 50.7% of the variance. The first factor, Emotional Support, accounted for 20.1% of the variance. The following items mainly defined this factor: I try to calm him/her down (0.84), I try to comfort him/her (0.81), and I help him/her (0.68). Factor 2, Positive Attention, explained 18.3% of the variance. Items with high loadings were: I talk to him/her (0.78), I pay attention to him/her (0.67), I ignore him/her (-0.64), and I do nothing (-0.50). Factor 3, accounting for 12.3% of the variance, had one item with a high loading, namely I get angry with him/her (-0.72). This factor, labeled Expressing Negative Affect, was recoded implying that a high score on this factor means a high tendency to express negative affect.

**Multilevel regression analyses**

The results of the multilevel regression analyses are summarized in Table 1. As can be seen, the proposed model explained a substantial proportion of the variances of all the nine factors. Given the focus of the research questions, only the main effects of crying status and the significant interaction effects between crying status and the other independent variables will be commented upon in the Results section. Figures 1 through 3 graphically illustrate the main effects of crying status.

*Person perception*

A crying person was perceived less positive and more emotional than a non-crying person (see Figure 1). For the factor Negative Characteristics, the main effect of crying status was not significant. The distinction in judging a crying person more emotional than a non-crying person was greater when the person was a man ($F = 591.92$, $p < .001$) than a woman ($F = 298.55$, $p < .001$), and when the person was a stranger ($F = 434.81$, $p < .001$) instead of a friend ($F = 373.65$, $p < .001$). Whereas female respondents ascribed less negative characteristics to a crying person than to a non-crying person ($F = 36.19$, $p < .001$), male respondents did not differentiate between a crying and a non-crying person ($F = 3.80$, $p = .05$). Additionally, it appeared that a crying person was judged less negative and more emotional than a non-crying person in both positive and negative situations, but that these differences were greater in negative situations ($F = 35.72$ and $F = 477.01$, $ps < .001$) than in positive situations ($F = 6.23$ and $F = 340.23$, $ps < .05$). The difference in describing less positive characteristics to a crying person than to a

**Table 1.** T-values belonging to the significant predictors of the dependent variables (N = 530)

| | Person perception | | | Experienced emotions | | | Overt behavior | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | NC | PC | E | NF | PF | S | ES | PA | ENA |
| Sex respondent (SR) | | | | | | | | 3.98** | |
| Crying status (C) | | -5.67** | 14.45** | 3.52** | | -5.14** | 6.62** | | -3.54** |
| Sex other person (SP) | -2.15* | | 6.40** | | | | | 2.52* | |
| Relationship with other person (R | | 8.79** | 2.92* | 3.01* | 8.31** | 9.12** | 2.73* | 15.06** | |
| Valence of situation (V) | -15.74** | 38.42** | 7.10** | -14.35** | 44.23** | -4.16** | -43.89** | | -25.26** |
| C x SR | -2.24* | | | | | | 3.19* | | |
| C x SP | | | -2.67* | | | 2.15* | 2.21* | | |
| C x R | | | -2.03* | -2.35* | -2.36* | | 2.00* | | |
| C x V | 5.49** | -12.09** | -4.77** | 4.91** | -4.73** | -5.26** | 12.52** | -3.06* | 4.25** |
| SR x SP | | -2.62* | | | | | | -2.79* | |
| C x SR x SP | | | | | | | | | |

*Note.* $R^2$ = .28 for Negative Characteristics (NC); $R^2$ = .64 for Positive Characteristics (PC); $R^2$ = .51 for Emotionality (E); $R^2$ = .31 for Negative Feelings (NF); $R^2$ = .61 for Positive Feelings (PF); $R^2$ = .39 for Sympathy (S); $R^2$ = .64 for Emotional Support (ES); $R^2$ = .37 for Positive Attention (PA); $R^2$ = .35 for Expressing Negative Affect (ENA).
* $p < .05$. ** $p < .001$.

non-crying person was greater in positive situations ($F = 317.93, p < .001$) than in negative situations ($F = 16.60, p < .001$).

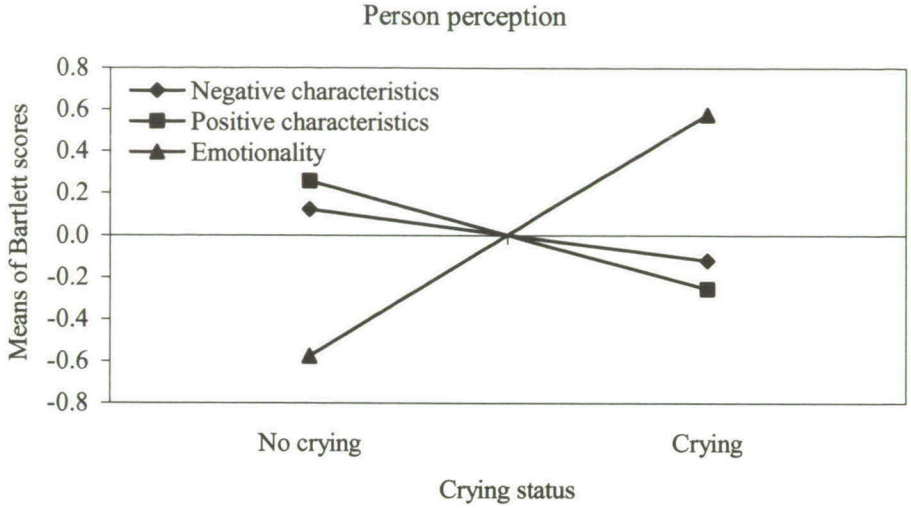


**Figure 1.** Means of the Bartlett scores on person perception as a function of crying status

*Experienced emotions*

Participants reportedly experienced more negative feelings and less sympathy in the presence of a crying than a non-crying person (see Figure 2). No significant main effect of crying status was found for the factor Positive Feelings. While both crying men and crying women elicited less sympathy than their non-crying counterparts, this difference was greater for men ($F = 67.62, p < .001$) than for women ($F = 5.75, p < .05$). A crying friend elicited the same amount of negative feelings as a non-crying friend ($F = 1.87, p = .17$), but a crying stranger elicited more negative feelings than a non-crying stranger ($F = 12.90, p < .001$). Both friends and strangers elicited less positive feelings when they cried than when they did not cry, but this difference was greater for friends ($F = 12.23, p < .001$) than for strangers ($F = 4.87, p < .05$). Moreover, in negative situations, respondents experienced as much negative feelings and positive feelings in the presence of a crying person as in the presence of a non-crying person ($F = 0.15$ and $F = 0.51$, *ps* $> .47$), whereas in positive situations they experienced more negative feelings and less positive feelings when the other person cried than when this person did not cry ($F = 51.52$ and $F = 37.85$, *ps* $< .001$). A crying person elicited less sympathy in both positive and negative situations, but this difference was greater in positive situations ($F = 96.15, p < .001$) than in negative situations ($F = 3.88, p < .05$).

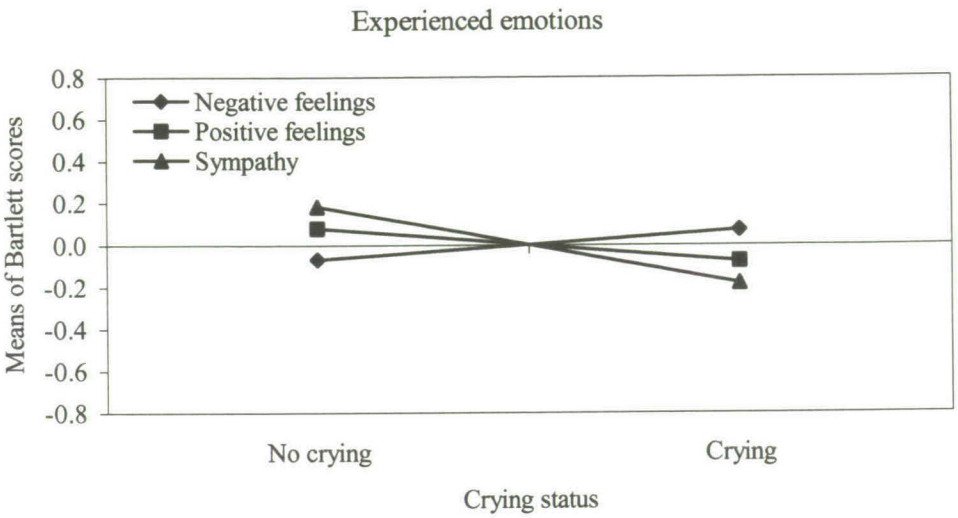


**Figure 2.** Means of the Bartlett scores on experienced emotions as a function of crying status

*Overt behavior*

Participants tended to give more emotional support to and to express less negative affect toward a crying person than to(ward) a non-crying person (see Figure 3). Crying status failed to significantly influence the factor Positive Attention. The distinction in providing more emotional support to a crying person than to a non-crying person was greater for female respondents ($F = 383.58$, $p < .001$) than for male respondents ($F = 84.47$, $p < .001$), was greater when the person was a woman ($F = 255.42$, $p < .001$) instead of a man ($F = 211.65$, $p < .001$) and was greater when the person was a stranger ($F = 235.60$, $p < .001$) rather than a friend ($F = 231.56$, $p < .001$). In both positive and negative situations, participants gave more emotional support to and expressed less negative affect towards a crying than a non-crying person, but these differences were greater in positive situations ($F = 621.83$ and $F = 94.32$, $ps < .001$) than in negative situations ($F = 164.07$ and $F = 77.00$, $ps < .001$). Additionally, in a negative situation, participants gave as much positive attention to a crying individual as to a non-crying individual ($F = 2.45$, $p = .12$), whereas they gave more positive attention to a non-crying person than to a crying person in a positive situation ($F = 10.79$, $p < .01$).

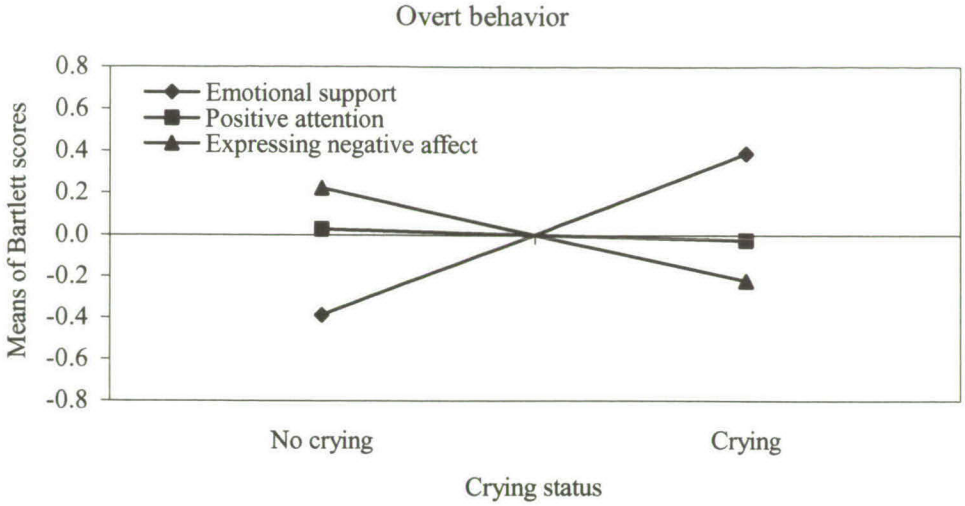


**Figure 3.** Means of the Bartlett scores on overt behavior as a function of crying status

## DISCUSSION

The objective of the present study was to explore the effects of crying on the social environment in terms of how a crying person is perceived and how other people feel and react toward a crying person. In addition, we aimed to examine the moderating influence of several person characteristics and aspects of the context on these reactions to crying. The present study extended the knowledge of the social effects of crying by manipulating the relationship with the (non-)crying person and the valence of the situation.

The results concerning the main effects of crying generally supported our expectations. More specifically, in line with several researchers (Cornelius, 1982; Cornelius & Lubliner, 2003; Cornelius et al., 2000; Hendriks & Vingerhoets, submitted; Hill & Martin, 1997; Labott et al., 1991; Wagner et al., 1997), it appeared that a crying person was judged more emotional and was more likely to be comforted than a non-crying person. The hypothesis that an important function of crying is to seek and evoke help of other people (e.g., Frijda, 1997; Kottler & Montgomery, 2001; Vingerhoets et al., 2000) was also supported; a crying person was more likely to receive emotional support than a non-crying person. Moreover, participants tended to express less negative affect (i.e., anger) toward a crying person than toward a non-crying person confirming the idea that crying inhibits aggressive behavior (Kottler & Montgomery, 2001). However, in contrast to some studies (Cornelius, 1982; Wagner et al., 1997; Hill & Martin, 1997), our results suggest that observers experienced *less* sympathy in the presence of a crying than

of a non-crying person. In addition, individuals reported more negative feelings in the presence of a crying than of a non-crying person, and judged a crying person less positive than a non-crying person.

In short, participants ascribed more negative characteristics to a crying person than a non-crying person, and experienced more negative emotions in the presence of a crying person than of a non-crying person. Nevertheless, at the same time, they indicated a greater willingness to support a crying person than a non-crying person. This raises the intriguing question what motivates people to help a crying person. Batson, O'Quin, Fultz, Vanderplas, and Isen (1983) have distinguished two different emotional responses to seeing another person suffer, namely personal distress and empathy. The reduction of personal distress might be regarded as an egoistic motivation, whereas empathy might be considered an altruistic motivation to help (Batson et al., 1983). The present findings suggest that people mainly help a crying person for egoistic rather than altruistic reasons. This supports the notion of Averill (1968) and of Bell and Ainsworth (1972) that the ability of crying to arouse displeasure or alarm in others is exactly what provides tears the power to promote proximity more effectively than any other signaling behavior.

The present study further focused on possible moderating effects of the social reactions to crying, and showed that the interaction between crying status and the valence of the situation was the most important predictor of the regression model. In accordance with our expectations that crying would result in more approach behavior in positive situations than in negative situations, the distinction in providing more emotional support to and expressing less negative affect toward a crying person than toward a non-crying person was greater in positive than in negative situations. Additionally, perceiving a crying person as more emotional than a non-crying person was more prevalent in negative situations. However, all the other significant interactions between crying status and valence disconfirmed the expectations revealing that participants reacted more positively to a crying person in negative situations than in positive situations. This again confirms the idea of Averill (1968) and of Bell and Ainsworth (1972) that the power of crying should mainly be ascribed to its ability to arouse displeasure in others. An alternative explanation is that the perceived appropriateness of crying in a certain situation is important. Anecdotal evidence has suggested that tears that are considered as inappropriate or insincere may evoke negative reactions such as frustration and irritation in others and may even be considered as blackmail (e.g., Frijda, 1986, 1997; Hill & Martin, 1997; Nelson, 2000). As an example, crying on the job is often considered as inappropriate (Hoover-Dempsey, Plas, & Wallston, 1986), and Wagner et al. (1997) did find that medical students who cried at work were sometimes ridiculed, looked at with contempt or screamed at by their colleagues. It could very well be that crying in a positive situation is generally perceived as less appropriate and called for than crying in a negative situation

resulting in more negative outcomes. Future research should therefore also measure the perceived appropriateness and determine whether it moderates the effects of crying on the social environment.

Contrary to our expectations, the relationship with the (non-)crying person failed to be a very important moderator of the social reactions to crying. In accordance with our hypothesis, participants experienced more negative feelings in the presence of a crying person if it was a stranger and especially judged a crying stranger as more emotional. However, the results also demonstrated that more than a crying friend, a crying stranger received emotional support and more than a crying stranger, a crying friend decreased the experienced positive feelings. These findings thus disconfirmed that crying is mainly designed to elicit care-taking behavior from intimate others (Bowlby, 1969). This might indicate that crying is not merely a means to endorse an already existent bond between intimates but additionally is a very effective way to form a new social bond even between complete strangers. Possibly, crying lowers the threshold to invade into the personal space of others. Viewed this way, crying should be regarded as a potent means to bring about social cohesion, which is very important for a social animal such as the human being.

One of the remarkable findings of the current study is the lack of moderating effects involving the sex of the respondent and the sex of the (non-)crying person. In general, female respondents did not respond more favorably toward a crying person than male respondents and the crying of a man did not result in more negative outcomes than the crying of a woman. A possible explanation for the lack of influence of the sex of the (non-)crying person is that sex role expectations have changed over the last few years. As suggested by Labott et al. (1991), it might nowadays be more accepted and appreciated that a man expresses his emotions, for instance, through crying. A crying man might even be considered as attractive, since he shows his sensitivity, whereas a man who is not able to shed tears when the situation asks for it might be viewed as cold and emotionally distant. Extending this argument, men might be more in touch with their emotional side and therefore feel less awkward in the presence of a crying person than they did some years ago explaining the lack of significant interactions between crying status and sex of the respondent.

A shortcoming of the present study is that selection bias of the sample might have played a substantial role. Although the sample included participants of all adult age-categories from the general population and not just students (as was the case in all the previous studies, except the study of Wagner et al., 1997), most respondents were volunteers who reacted to announcements in newspapers and magazines that mentioned the subject of crying. Consequently, these volunteers were people with a certain interest in crying, and might contain a relative high proportion of individuals, especially among the men, who cry easily or for whom this has been a problem in the past. In addition, the respondents probably had more

positive attitude towards crying and therefore might have reported more positive reactions toward a crying person than a representative sample of the general population would have. In other words, without a replication of the present findings in a more representative group of participants, one cannot conclude that crying elicits help from all people.

Furthermore, a few well-known limitations of the vignette method have to be considered. In particular, the ability of this method to predict actual behavior in real everyday life may be questioned (Lanza & Carifio, 1992; Parkinson & Manstead, 1993). Rather, one may assume that the vignette method measures stereotypes and social representations instead of actual behavior and therefore the results mainly indicate what kind of effects crying *can* have instead of what effects it *typically does* have in real life. However, we believe that the methodology is adequate for our present purposes. Measuring people's beliefs about their responses to a crying person is an important first step in generating hypotheses about actual behavior. In future research, these hypotheses should be tested in studies that measure the actual behavior in response to a crying person as compared to a non-crying person.

In sum, our hypothesis that crying is a communicative signal with a high potential to elicit emotional support and inhibit aggressive behavior was confirmed. However, at the same time, a crying person could not count on more sympathy or attention of others than a non-crying person. More than that, a crying individual was perceived more negatively and mainly elicited negative feelings in other people. The supporting behavior toward a crying person thus probably reflected an egoistic motive of people to help, that is, individuals help a crying person in order to reduce their own distress. Contrary to our expectations, the social reactions to crying were not substantially moderated by the sex of the respondent, the sex of the (non-)crying person or the relationship with the (non-)crying person. Only the situation in which a person cried appeared to be an important moderator of the reactions from the social environment. Future research should try to determine whether these moderating effects could be explained by the perceived appropriateness of crying in a certain situation. It short, crying can be regarded as an alarming call, which effectively solicits the help of others. This might especially hold in negative situations in which crying is deemed appropriate.

## APPENDIX

### The vignettes in English translated from the original Dutch

In this appendix, the wording of each vignette is given with the main character encountering an unfamiliar man and a male friend. However, each vignette also occurred with an unfamiliar woman and a female friend. In parentheses are the words that were added in the condition of a crying person.

*Negative situations*

*Talking to someone at a funeral.* You are at the funeral of the father of one of your colleagues. During the condolences you are talking /with an unfamiliar man, who is standing behind you/ with a male friend/ about how terrible this must be for your colleague. (The unfamiliar man/ your friend starts to cry.)

*Causing a car crash.* You are on your way home from work in your car. When you approach a road with right-of-way you to late see a car coming from the right. You cannot avoid the car and both cars bump into each other. /Both of you get out of the car. The other person, an unfamiliar man, starts yelling at you and it turns into a fight./ When both of you get out of the car, the man in the other car appears to be a good friend of yours. He starts yelling at you and it turns into a fight./ (The unfamiliar man/ he starts to cry.)

*Watching someone drops an expensive vase at a party.* You are at a party and when you are in the kitchen pouring yourself a drink /an unfamiliar partygoer/ a male friend/ drops a dish with snacks. Furthermore, he upsets an expensive vase. (He/ your friend starts to cry.)

*Positive situations*

*Awarding a colleague before an audience.* As a manager in a company it is your job to make people the center of attention when they put up a tremendous performance. This time it is /a rather unfamiliar man/ a male friend of yours/, who works at the reception. When you have finished your speech and give him his present, he thanks you for your nice words (and starts to cry).

*Meeting someone who wins a prize in a lottery.* You are attending a prize giving of a lottery. When /the unfamiliar man/ your male friend/, who is sitting next to you, wins a trip to America he is very happy (and starts to cry).

*Meeting someone who tells you that (s)he has become a parent.* /You are at the registry office getting a new passport. The unfamiliar man in front of you tells you that he has become the father of a beautiful baby girl./ You are at the registry office getting a new passport when you run into a good friend of yours. He tells you he has become the father of a beautiful baby girl./ He is very happy. (He is so happy, that he starts to cry.)

# CHAPTER 5
# The social messages of crying faces: Their influence on person perception, experienced emotions and reported overt behavior of others*

## INTRODUCTION

The role of facial expressions in human interaction has been a subject of interest for several decades. Facial expressions are primarily considered communicative acts and an expressing individual is thought to provide information about him/herself with the aim to cause particular changes in the social environment (e.g., Cornelius & Labott, 2001; Frijda, 1997; Kottler & Montgomery, 2001). Until present, only a few empirical studies have been carried out concerning the influence of facial expressions on other people (e.g., Blairy, Herrera, & Hess, 1999; Hess & Blairy, 2001; Hess, Blairy, & Kleck, 2000; Knutson, 1996; Lundqvist & Dimberg, 1995). Crying, although considered as a powerful signal in communication (Cornelius & Labott, 2001; Kottler, 1996), has almost never been included in these studies (for exceptions see Cornelius & Lubliner, 2003; Cornelius et al., 2000). Therefore, the objective of the present study was to determine how people respond to different emotional facial expressions, including crying faces.

There are three main perspectives on what kind of information is communicated by facial expressions. According to the *emotion expression view* (e.g., Ekman, 1972; Izard, 1977; Tomkins, 1962), there are a number (six to ten) of basic emotions and each of these emotions consists of a coherent pattern of several components, including facial expression and subjective feelings. Facial behavior expresses the accompanying internal emotional feeling state. Emotions automatically give rise to this facial behavior, except when individuals consciously regulate their facial expressions. In contrast, according to Fridlund's (1992, 1994) *behavioral ecology view*, facial expressions signal our social motives or intention to others and are by no means directly related to experienced emotions. Expressions have their impact upon others' behavior because vigilance for and comprehension of signals coevolved with the signals themselves. Lastly, the *components view* (e.g., Carroll & Russell, 1997; Frijda & Tcherkassof, 1997;

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* Hendriks, M. C. P. & Vingerhoets, A. J. J. M. (submitted). The social messages of crying faces: Their influence on person perception, experienced emotions and reported overt behavior of others.

Horstmann, 2003; Manstead et al., 1999; Smith & Scott, 1997) combines the emotion expression view and the behavioral ecology view. Comparable with the emotion expression view, it describes emotions in terms of several component processes. However, these components are considered dissociable and only moderately related. Emotional feelings and social motives can both be regarded as components of the emotion process and can both in principle influence the occurrence of facial expressions, which is another component of the emotion process. Despite their disagreements, all three perspectives acknowledge the communicative function of facial expressions and the possible influence of facial expressions on the social environment.

Concerning crying, the effects on the social environment have also been emphasized (Vingerhoets et al., 2000). Crying is a ubiquitous and uniquely human form of emotional expression that communicates to others that one is suffering and wants to receive attention or succor (Cornelius & Lubliner, 2003; Fridlund, 1992; Nelson, 1998, 2000). It has been suggested that the main function of crying is to stimulate others to help to remove a given source of discomfort and to elicit attention, empathy, and support (Frijda, 1986, 1997; Kottler, 1996; Kottler & Montgomery, 2001; Nelson, 1998, 2000; Sadoff, 1966). Adult crying can thus be regarded as an attachment behavior, since attachment behaviors are known to trigger a reciprocal set of caretaking behaviors in others (Bowlby, 1973; Cornelius & Lubliner, 2003; Nelson, 1998, 2000). However, until present, almost no systematic research has been done on the influence of crying faces on the social environment.

Only Cornelius and colleagues (Cornelius & Lubliner, 2003; Cornelius et al., 2000) have made a more systematic attempt to determine how people react to crying expressions. Cornelius et al. (2000) found that participants rated photos of tearful faces as more emotional and more likely to be indicative of sadness and grief than photos of the same faces with the tears digitally removed. Participants thought that crying people mainly communicated the message that they want help, comfort or taken care of (Cornelius & Lubliner, 2003; Cornelius et al., 2000). The faces with the tears digitally removed, referred to as 'non-tearful' faces, were thought to communicate the same message, although to a lesser degree (Cornelius & Lubliner, 2003). Cornelius and Lubliner (2003) additionally let participants indicate how they would respond to the person on the photo. The majority of participants who viewed a tearful face (59.0%) indicated that they would comfort the person, whereas the majority of respondents who viewed a non-tearful face (52.1%) indicated that they would ask the person what was wrong. A larger percentage of those who saw a non-tearful face (26.0%) reported they would leave the person alone as compared to those who saw a crying face (19.6%). These results are in accordance with an attachment approach to crying that predicts that an important function of crying is to elicit caretaking behavior. Unfortunately, Cornelius and colleagues (Cornelius & Lubliner, 2003; Cornelius et al., 2000) did

not ask how the participants felt while watching the (crying) faces. Reported emotions may yield important information concerning the motives behind the tendency of people to comfort a crying individual. In addition, the studies failed to compare the social reactions to crying faces with the social reactions to other emotional expressions.

In order to determine whether crying communicates a specific message different from other emotional expressions, the social reactions to crying expressions can be compared with those to sadness, anger and fear expressions. According to Frijda (1997), both crying, anger and fear expressions can be used to influence the balance of power between people and all three communicate the message that the other person has to stop whatever s/he is doing. Whereas anger expressions are mostly considered as intimidation behavior ('back off or I will attack'), fear and crying expressions are generally considered help-seeking behavior ('you had better do something about it'; Frijda, 1997). Of fear expressions, it is thought that they typically communicate the message 'don't hurt me. I give up' (Frijda, 1997; Yik & Russell, 1999). Crying faces presumably convey the same messages as sad faces, namely that one is feeling sad and in need of comfort and help ('please hold me and comfort me'; Cornelius & Lubliner, 2003; Cornelius et al., 2000; Yik & Russell, 1999).

The few empirical studies done thus far on the social reactions to sadness, anger and fear expressions have mainly focused on the effects of facial expressions on person perception and experienced emotions of the observers. Hess et al. (2000) and Knutson (1996) both demonstrated that photos or video clips of anger expressions received lower ratings of affiliation and higher ratings of dominance than photos or video clips of fear and sadness expressions. In contrast, the differences between fear and sadness expressions in ratings of affiliation and dominance were not that clear-cut and pronounced. Knutson (1996) suggested that anger expressions can be best characterized as attack expressions, whereas fear and sad expressions are typical avoid expressions. According to Hess et al. (2000), anger is associated with rejection, while fear and sadness are associated with helplessness.

With regard to experienced emotions, Lundqvist and Dimberg (1995) found that photos of sadness, anger and fear expressions generally elicited the same emotion in observers as expressed by the person on the photo. Anger expressions additionally elicited feelings of disgust and fear, and fear expressions also elicited feelings of disgust. Blairy et al. (1999) performed two experiments in which participants viewed, among other photos, photos of angry, fearful and sad faces. The first experiment did not yield any differences between angry, fearful and sad faces, whereas the second experiment showed that fearful faces elicited more feelings of fear than the angry and sad faces. Finally, Hess and Blairy (2001) demonstrated that watching video clips of sad expressions elicited more feelings of sadness than watching clips of anger expressions.

In short, the studies so far have demonstrated that the type of facial expression influences which person characteristics are attributed to the depicted individual and which emotions the observers experience. More specifically, people with angry faces were rated more dominant and less affiliative than people with sad and fearful faces. Emotional facial expressions mostly elicited the corresponding emotion in the observers indicating the presence of emotional contagion and/or empathy (Hatfield, Cacioppo, & Rapson, 1994; Mehrabian & Epstein, 1972). However, the studies failed to focus on the influence of crying faces on others and on the effects of facial expressions on actual behavior or behavioral tendencies of the observers.

In the present study, male and female respondents were exposed to photos of male and female faces depicting eight different facial expressions and indicated how they perceived the person on the photograph and how they would feel and respond in presence of this person. The present article focuses on the reactions to crying, neutral, angry and fearful faces. We examined whether the type of expression, sex of the poser, sex of the respondent, and the interactions between these factors influenced the social reactions to facial expressions. Furthermore, a significant main effect of the type of expression was followed by post-hoc comparisons to compare more thoroughly the responses to crying faces with the responses to neutral, angry and fearful faces, respectively. Following Frijda (1997), Hess et al. (2000) and Knutson (1996), it was expected that crying faces would elicit different social reactions than angry faces, but that the differences in social reactions to crying and fearful faces would not be that pronounced. More specifically, it was hypothesized that crying people would be perceived as less dominant and more affiliative than people with angry faces, and that crying expressions would elicit more feelings of sadness than any of the other expressions. Concerning the behavior of other people, it can be postulated that crying expressions stimulate, whereas anger expressions discourage approach behavior by the other person. Since crying may be considered an attachment behavior, it was anticipated that, compared with the other facial expressions, crying faces would elicit more empathy and support (i.e., caretaking behavior) in the observing participants.

## METHOD

### Participants

One hundred and twenty-three people participated in the present study. Respondents were 94 first-year psychology students (27 male, 67 female), who received course credit for participation, and 29 first-year economy students (all male), who received a financial reward (7 euro) for participation. 104 respondents (84.6%) had usable data; the data of 19 participants were removed, because they had too many missing data (over 20%) due to lack of time. The final group

consisted of 47 men aged from 17 up to 30 years ($M$ = 19.7, $SD$ = 2.5), and of 57 women aged from 18 up to 32 years ($M$ = 20.2, $SD$ = 3.1).

**Measures and design**

*Stimulus material*

Photos of six men and six women posing the following eight facial expressions served as stimuli: neutral, smiling, laughing, fear, anger, crying (tears were elicited with eye drops), yawning, and sticking tongue out. These 96 photos were selected from a larger set of photos based on their recognition rate as measured in a pilot study. Complete series of photos (i.e., series containing all the eight facial expressions of one particular poser) that had an average recognition-rate of 50% or higher were selected for the present study. The series of each poser was divided into two subsets. Subset A contained the neutral, laughing, fear and sticking-tongue-out expression, and Subset B contained the smiling, anger, crying and yawning expression. Subsequently, four sets of 24 photos were formed, each of which contained three subsets A and three subsets B and contained the photos of three male and three female posers. Different participants evaluated each set of photos; 24 participants evaluated Set I, 27 participants evaluated Set II, 30 participants evaluated Set III, and 23 participants evaluated Set IV.

*Dependent variables*

The dependent variables of the present study included measures of person perception, experienced emotions and reported overt behavior. The items were based on scales that were applied by several other researchers (Hendriks, Vingerhoets, & Croon, submitted; Labott et al., 1991; Timmers, Fischer, & Manstead, 1998; Zillmann et al., 1986).

*Person perception.* The respondents were asked the following question: 'What do you think of the depicted person? To what extent do the following characteristics describe this person?' Response alternatives were the following twelve bipolar dimensions, each of which had to be rated on a 1-to-10 rating scale: pitiable-not pitiable, clever-dull, not aggressive-aggressive, feminine-masculine, strange-normal, insecure-secure, stable-unstable, squeamish-not squeamish, pleasant-unpleasant, calm-nervous, sensitive-insensitive, and active-passive.

*Experienced emotions.* The respondents had to answer the following question: 'How do you feel in the presence of the depicted person? To what extent do you experience the following emotions when you are alone in a room with this person?' The following fourteen state indicators had to be rated on a 4-point rating scale varying from 1 (not at all) to 4 (very much): angry, startled, bored, touched, fearful, relaxed, aversion, astonished, normal, powerless, sad, happy and uncomfortable.

*Reported overt behavior.* Lastly, the respondents had to answer the following question: 'How do you react to the depicted person? To what extent are you inclined to react in the following ways when you are alone in a room with this person?' The following eleven options, each of which had to be rated on a 4-point rating scale varying from 1 (certainly not) to 4 (certainly so), were presented: I try to comfort him/her, I avoid him/her, I am happy for him/her, I pay attention to him/her, I help him/her, I try to calm him/her down, I get angry with him/her, I have sympathy for him/her, I start to cry, I do nothing, I talk with him/her, and I ignore him/her.

**Procedure**

Participants were individually seated in soundproof cubicles separated from each other by partitions. Forty-two groups of respondents with a maximum of 12 people per group participated. The four different sets of photos were randomly distributed among the respondents while trying to balance the number of men and women who viewed each set. The participants were informed that they were going to view 24 photos on a computer screen and that every photo would stay on the screen for 110 seconds. Moreover, they were told that the same person would be presented several times with different facial expressions. Participants were instructed to watch each photo carefully and were requested to report how they perceived the other person, how they themselves would feel in the presence of the person and how they would react (to the other person). The photos appeared in a random order on the computer screen at 12.3 inch (31.3 cm) wide and 8.3 inch (21.0 cm) tall, with a resolution of 72 pixels per inch (28.3 pixels per cm). A beep and the number of each photo preceded the appearance of each photo.

**Statistical analyses**

Using the Expectation Maximization (EM) method in SPSS 11.5, missing data (4.7%) were estimated for each photo and each set of dependent variables (i.e., person perception, experienced emotions and reported overt behavior) separately. The EM method is an iterative process in which a missing data correlation or covariance matrix is formed by assuming the shape of a normal distribution for the partially missing data, and in which inferences about missing values are made on the likelihood under that distribution (Tabachnick & Fidell, 2001). If applicable, the ratings of males posing the same expression were averaged and the ratings of females posing the same expression were averaged. Subsequently, the ratings of the four different sets of photos were collapsed into one data set.

In order to reduce the number of dependent variables, factor analyses were conducted on the three sets of dependent variables separately. An exploratory factor analysis was carried out on the matrix containing the item correlations computed over all combinations of subjects and ratings. In other words, a total of 104 (number of respondents) x 8 (type of expression) x 2 (sex of poser) = 1664

observations were available to compute the correlation between any two items in a scale. The eigenvalue-equals-one rule was used to determine the number of factors. Subsequently, a principal axis factoring was carried out for each set of dependent variables, and the resulting solutions were orthogonally rotated by means of the VARIMAX procedure with Kaiser Normalization implemented.

Given the focus of the present research questions, the main analyses only included the ratings of crying, neutral, anger and fear expressions. GLM repeated measures analyses were performed with type of expression (crying, neutral, anger and fear) and sex of the poser as within-subject factors, and sex of the respondent as a between-subject factor. Bartlett scores were used as dependent variables, because this allows for a consistent estimation of the true factor scores (Croon, 2002; Skrondal & Laake, 2001; Tabachnick & Fidell, 2001). If the main effect of type of expression was significant, post-hoc comparisons were applied to determine whether the means of the Bartlett scores for crying expressions differed from the means of the Bartlett scores for any of the other three facial expressions. Using the Bonferroni correction, the significance level for these post-hoc comparisons was set on $p < .01$.

## RESULTS

### Factor analyses

*Person perception*

Factor analysis yielded four factors, which together explained 54.3% of the total variance. Factor 1, accounting for 19.9% of the variance, was defined by high loadings on the dimensions stable-unstable (-0.75), insecure-secure (0.75), pitiable-not pitiable (0.69), and calm-nervous (-0.62). The factor was referred to as Emotional Stability. Factor 2 was labeled Squeamishness, because it mainly included the dimensions strange-normal (-0.76), squeamish-not squeamish (-0.67), clever-dull (0.64), and pleasant-unpleasant (0.59). This factor explained 18.2% of the variance. Factor 3, referred to as Aggression, explained 9.8% of the variance. The dimensions sensitive-insensitive (0.63), not aggressive-aggressive (0.62) and feminine-masculine (0.38) mainly defined this factor. The fourth factor had only one item with a high loading, namely active-passive (0.72) and was therefore labeled Passivity. This factor explained an additional 6.4% of the variance.

*Experienced emotions*

Factor analysis yielded three common factors, which together explained 53.4% of the variance. Factor 1, called Discomfort, was best characterized by the items uncomfortable (0.74), startled (0.72), normal (-0.71), relaxed (-0.69), fearful (0.67), and astonished (0.62). This factor explained 28.4% of the total variance. The second factor, labeled Sadness, explained 15.9% of the variance and included the items touched (0.83), sad (0.80) and powerless (0.55) as most important items. Factor 3, accounting for another 9.2% of the variance, was called Aversion in view

of the fact that the items aversion (0.66) and bored (0.64) had high loadings on this factor.

*Reported overt behavior*
Factor analysis yielded three factors, explaining 55.5% of the variance. The first factor, Emotional Support, accounted for 26.3% of the variance. The following items primarily defined this factor: I try to calm him/her down (0.88), I try to comfort him/her (0.82), I help him/her (0.78), and I have sympathy for him/her (0.62). Factor 2, Avoidance, explained 21.7% of the variance. Items with high loadings were: I avoid him/her (0.78), I ignore him/her (0.75), I talk with him/her (-0.68), I get angry with him/her (0.54), and I do nothing (0.48). Factor 3, accounting for 7.6% of the variance, had only one item with a high loading, namely I am happy for him/her (0.70). This factor was labeled Expressing Happiness.

**GLM repeated measures**
The results of the repeated measures analyses are summarized in Tables 1 through 3. The results of the univariate instead of the multivariate approach are reported, since both the Greenhouse-Geisser and the Huyhn-Feldt epsilons were above .70 (Stevens, 1996). The probability values were adjusted using the Greenhouse-Geisser procedure. The means of the Bartlett scores on the dependent variables are represented as a function of the type of expression in Figures 1 through 3 and significant interaction effects are illustrated in Figures 4 through 9.

*Type of expression: Main effects and post-hoc comparisons*

*Person perception.* The type of expression significantly influenced the ratings of Emotional Stability, Squeamishness, Aggression and Passivity (see Figure 1). The post-hoc comparisons showed that posers of crying expressions were (a) regarded as less emotionally stable ($F(1, 102) = 247.16$, $p < .001$, *partial* $\eta^2 = .71$), more squeamish ($F(1, 102) = 7.83$, $p < .01$, *partial* $\eta^2 = .07$) and less aggressive ($F(1, 102) = 196.00$, $p < .001$, *partial* $\eta^2 = .66$) than posers of neutral expressions; (b) judged less emotionally stable ($F(1, 102) = 100.62$, $p < .001$, *partial* $\eta^2 = .50$), less squeamish ($F(1, 102) = 7.54$, $p < .01$, *partial* $\eta^2 = .07$), less aggressive ($F(1, 102) = 250.72$, $p < .001$, *partial* $\eta^2 = .71$), and more passive ($F(1, 102) = 45.03$, $p < .001$, *partial* $\eta^2 = .31$) than posers of anger expressions; and (c) rated less emotionally stable ($F(1, 102) = 50.95$, $p < .001$, *partial* $\eta^2 = .33$), less aggressive ($F(1, 102) = 71.29$, $p < .001$, *partial* $\eta^2 = .41$) and more passive ($F(1, 102) = 15.30$, $p < .001$, *partial* $\eta^2 = .13$) than posers of fear expressions. The ratings of Passivity did not differ significantly between crying and neutral expressions ($F(1, 102) = 1.96$, $p = .17$, *partial* $\eta^2 = .02$) and the ratings of Squeamishness did not differ significantly between crying and fear expressions ($F(1, 102) = 2.78$, $p = .10$, *partial* $\eta^2 = .03$).

**Table 1.** Summary of the repeated measures analyses on person perception

| Source | Emotional stability | | | Squeamishness | | | Aggression | | | Passivity | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ |
| | | | | | Between subjects | | | | | | | |
| Sex of respondent (SR) | 1.0 | 1.35 | .01 | 1.0 | 8.83** | .08 | 1.0 | 1.76 | .02 | 1.0 | 0.51 | .01 |
| | | | | | Within subjects | | | | | | | |
| Type of expression (T) | 2.8 | 104.60*** | .51 | 2.8 | 13.12*** | .11 | 2.6 | 134.62*** | .57 | 2.7 | 26.69*** | .21 |
| Sex of poser (SP) | 1.0 | 0.74 | .01 | 1.0 | 22.02*** | .18 | 1.0 | 39.41*** | .28 | 1.0 | 0.10 | .00 |
| T x SP | 2.8 | 6.89*** | .06 | 2.8 | 0.63 | .01 | 2.5 | 0.65 | .01 | 2.9 | 1.83 | .02 |
| T x SR | 2.8 | 2.72* | .03 | 2.8 | 0.96 | .01 | 2.6 | 3.29* | .03 | 2.7 | 0.95 | .01 |
| SP x SR | 1.0 | 0.03 | .00 | 1.0 | 1.59 | .02 | 1.0 | 0.99 | .01 | 1.0 | 0.41 | .00 |
| T x SP x SR | 2.8 | 0.51 | .01 | 2.8 | 1.46 | .01 | 2.5 | 0.33 | .00 | 2.9 | 1.39 | .01 |

*Note.* * $p < .05$. ** $p < .01$. *** $p < .001$.

**Table 2.** Summary of the repeated measures analyses on experienced emotions

| Source | Discomfort | | | Sadness | | | Aversion | | |
|---|---|---|---|---|---|---|---|---|---|
| | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ |
| | | | | Between subjects | | | | | |
| Sex of respondent (SR) | 1.0 | 2.00 | .02 | 1.0 | 0.10 | .00 | 1.0 | 15.98*** | .14 |
| | | | | Within subjects | | | | | |
| Type of expression (T) | 2.9 | 54.49*** | .35 | 2.2 | 197.64*** | .66 | 2.6 | 27.62*** | .21 |
| Sex of poser (SP) | 1.0 | 0.59 | .01 | 1.0 | 1.35 | .01 | 1.0 | 0.23 | .00 |
| T x SP | 2.7 | 2.38 | .02 | 2.7 | 2.94* | .03 | 2.9 | 0.96 | .01 |
| T x SR | 2.9 | 2.52 | .02 | 2.2 | 1.44 | .01 | 2.6 | 0.87 | .01 |
| SP x SR | 1.0 | 0.05 | .00 | 1.0 | 5.03* | .05 | 1.0 | 1.16 | .01 |
| T x SP x SR | 2.7 | 0.43 | .00 | 2.7 | 1.53 | .02 | 2.9 | 1.27 | .01 |

*Note.* * $p < .05$. ** $p < .01$. *** $p < .001$.

**Table 3.** Summary of the repeated measures analyses on reported overt behavior

| Source | Emotional support | | | Avoidance | | | Expressing happiness | | |
|---|---|---|---|---|---|---|---|---|---|
| | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ | df | F | partial $\eta^2$ |
| Between subjects | | | | | | | | | |
| Sex of respondent (SR) | 1.0 | 3.39 | .03 | 1.0 | 6.43* | .06 | 1.0 | 0.70 | .01 |
| Within subjects | | | | | | | | | |
| Type of expression (T) | 2.8 | 190.44*** | .65 | 2.9 | 50.01*** | .33 | 2.5 | 48.52*** | .32 |
| Sex of poser (SP) | 1.0 | 41.13*** | .29 | 1.0 | 0.01 | .00 | 1.0 | 0.34 | .00 |
| T x SP | 2.8 | 7.98*** | .07 | 2.6 | 0.58 | .01 | 2.7 | 1.21 | .01 |
| T x SR | 2.8 | 1.07 | .01 | 2.9 | 1.25 | .01 | 2.5 | 1.50 | .01 |
| SP x SR | 1.0 | 2.52 | .02 | 1.0 | 0.02 | .00 | 1.0 | 1.60 | .02 |
| T x SP x SR | 2.8 | 0.17 | .00 | 2.6 | 1.54 | .02 | 2.7 | 0.87 | .01 |

*Note.* * $p < .05$. ** $p < .01$. *** $p < .001$.

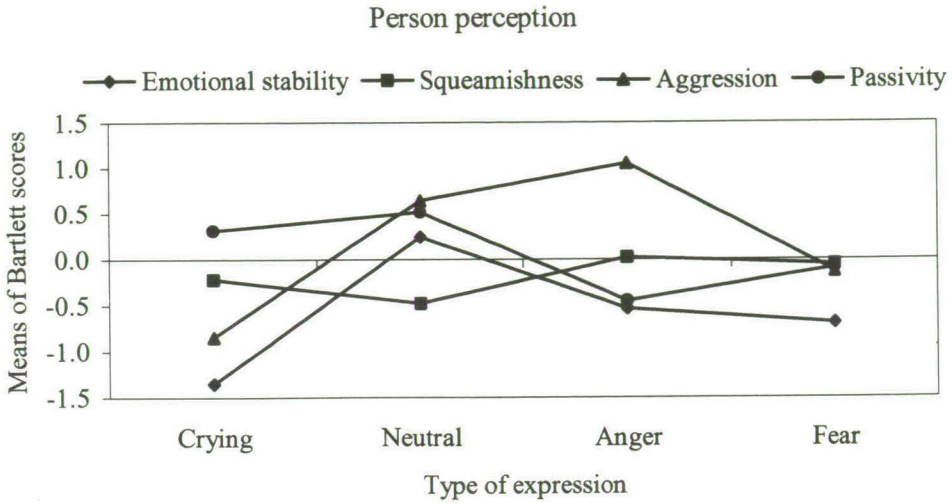


**Figure 1.** Means of the Bartlett scores on person perception for reactions to different types of facial expressions

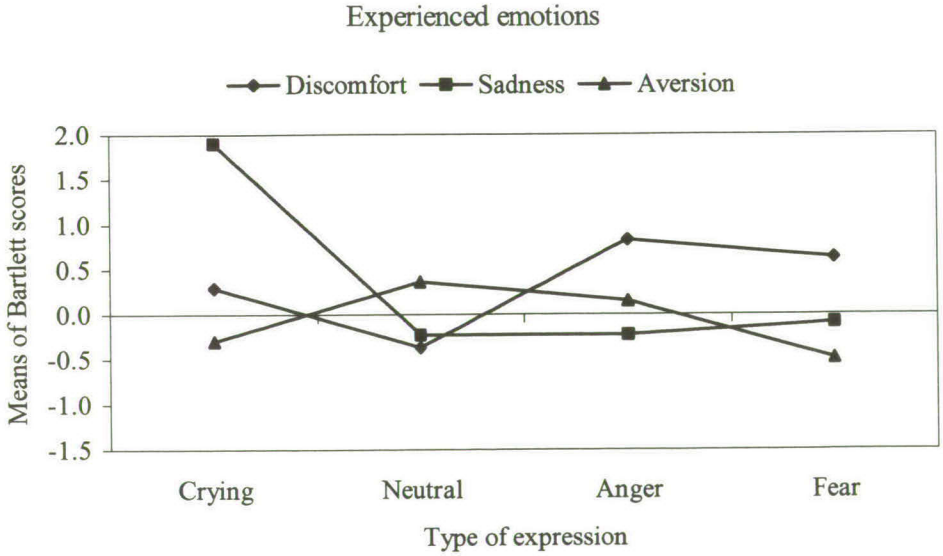


**Figure 2.** Means of the Bartlett scores on experienced emotions for reactions to different types of facial expressions

*Experienced emotions.* The main effect of the type of expression was significant for the ratings of Discomfort, Sadness and Aversion (see Figure 2). According to the post-hoc comparisons, crying expressions elicited (a) more discomfort ($F(1, 102) = 42.54$, $p < .001$, *partial* $\eta^2 = .29$), more sadness ($F(1, 102) = 282.74$, $p < .001$, *partial* $\eta^2 = .74$) and less aversion ($F(1, 102) = 30.81$, $p < .001$, *partial* $\eta^2 = .23$) than neutral expressions; (b) less discomfort ($F(1, 102) = 30.32$, $p < .001$, *partial* $\eta^2 = .23$), more sadness ($F(1, 102) = 269.03$, $p < .001$, *partial* $\eta^2 = .73$) and less aversion ($F(1, 102) = 30.49$, $p < .001$, *partial* $\eta^2 = .23$) than anger expressions; and (c) less discomfort ($F(1, 102) = 9.88$, $p < .01$, *partial* $\eta^2 = .09$) and more sadness ($F(1, 102) = 290.11$, $p < .001$, *partial* $\eta^2 = .74$) than fear expressions. The ratings of Aversion did not differ significantly between crying and fear expressions ($F(1, 102) = 3.76$, $p = .06$, *partial* $\eta^2 = .04$).

*Reported overt behavior.* The ratings of Emotional Support, Avoidance and Expressing Happiness were all significantly influenced by the type of expression (see Figure 3). The post-hoc comparisons revealed that respondents tended to give more emotional support to, to display less avoidance behavior toward and to express less happiness toward posers of crying expressions than to(ward) (a) posers of neutral expressions ($F(1, 102) = 445.16$, $p < .001$, *partial* $\eta^2 = .81$, $F(1, 102) = 49.64$, $p < .001$, *partial* $\eta^2 = .33$, and $F(1, 102) = 102.86$, $p < .001$, *partial* $\eta^2 = .50$, respectively); (b) posers of anger expressions ($F(1, 102) = 245.08$, $p < .001$, *partial* $\eta^2 = .71$, $F(1, 102) = 154.65$, $p < .001$, *partial* $\eta^2 = .60$, and $F(1, 102) = 112.29$, $p < .001$, *partial* $\eta^2 = .52$, respectively); and (c) posers of fear expressions ($F(1, 102) = 133.85$, $p < .001$, *partial* $\eta^2 = .57$, $F(1, 102) = 19.75$, $p < .001$, *partial* $\eta^2 = .16$, and $F(1, 102) = 70.29$, $p < 001$, *partial* $\eta^2 = .41$, respectively).

*Effects of sex of poser and of sex of respondent*

The main effect of sex of poser was significant for the ratings of Squeamishness, Aggression and Emotional Support. For male posers, the means (with standard deviations in parentheses) for Squeamishness, Aggression and Emotional Support were -0.3 (0.6), 0.4 (0.8) and 0.3 (0.7), respectively. The corresponding means and standard deviations for female posers were -0.1 (0.6), -0.1 (0.7) and 0.5 (0.7), respectively. Sex of respondent significantly influenced the ratings of Squeamishness, Aversion, and Avoidance. For male respondents, the means (with standard deviations in parentheses) for Squeamishness, Aversion and Avoidance were 0.0 (0.5), 0.2 (0.8) and 0.2 (0.8), respectively. The corresponding means and standard deviations for female respondents were -0.3 (0.6), -0.3 (0.6) and -0.2 (0.7), respectively. In other words, it appeared that male posers were judged less squeamish and more aggressive, and were less likely to receive emotional support than female posers, and that male respondents ascribed higher levels of squeamishness to the posers, experienced more aversion, and tended to avoid the posers more than female respondents.

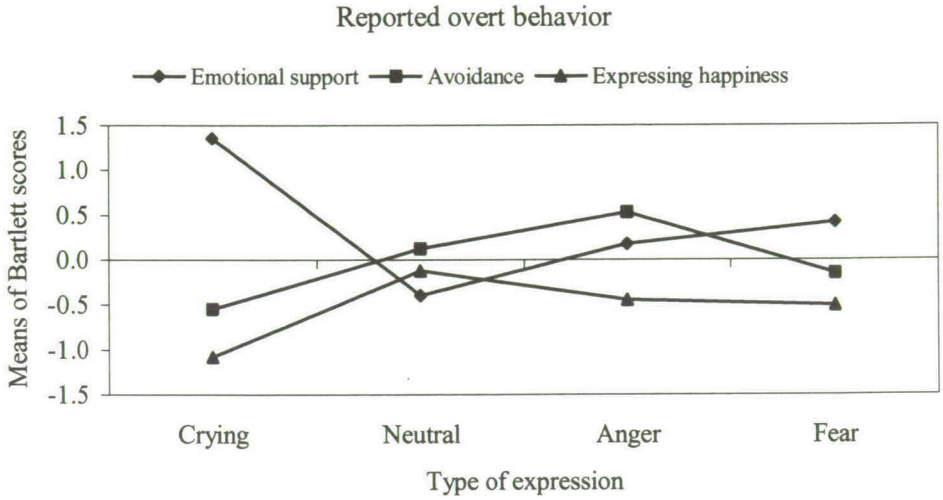


**Figure 3.** Means of the Bartlett scores on reported overt behavior for reactions to different types of facial expressions

The two-way interaction between type of expression and sex of poser was significant for the ratings of Emotional Stability, Sadness and Emotional Support (see Figures 4 through 6). As illustrated in Figures 7 and 8, the interaction between type of expression and sex of respondent significantly influenced the ratings of Emotional Stability and Aggression. For these significant interaction effects, the effect of type of expression mostly differed in magnitude and not in direction between the two sexes. Therefore, the post-hoc comparisons were not carried out for male and female posers or male and female respondents separately. The interaction between sex of respondent and sex of poser was significant for the ratings of Sadness. Figure 9 shows that same-sex posers elicited less feelings of sadness in the respondents than opposite-sex posers. Finally, the three-way interaction between type of expression, sex of poser and sex of respondent did not significantly influence any of the ratings.

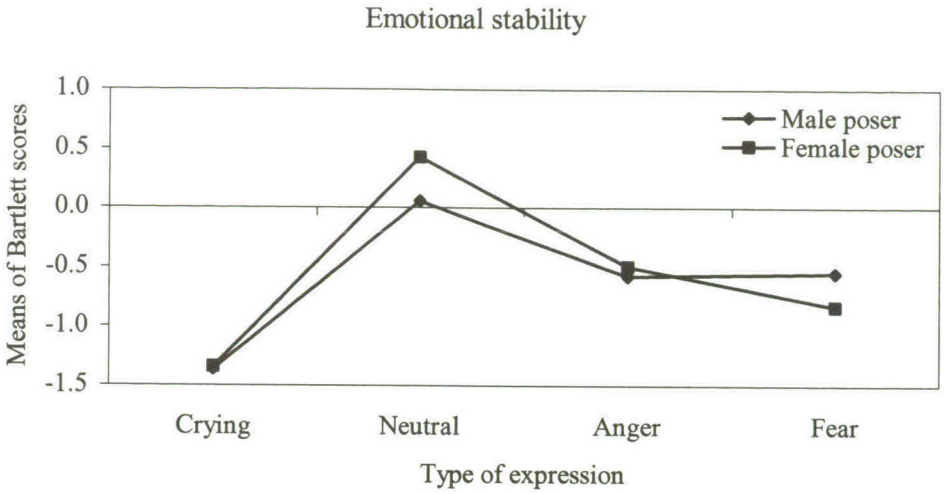


**Figure 4.** Means of the Bartlett scores on emotional stability for reactions to different types of facial expressions as a function of sex of the poser

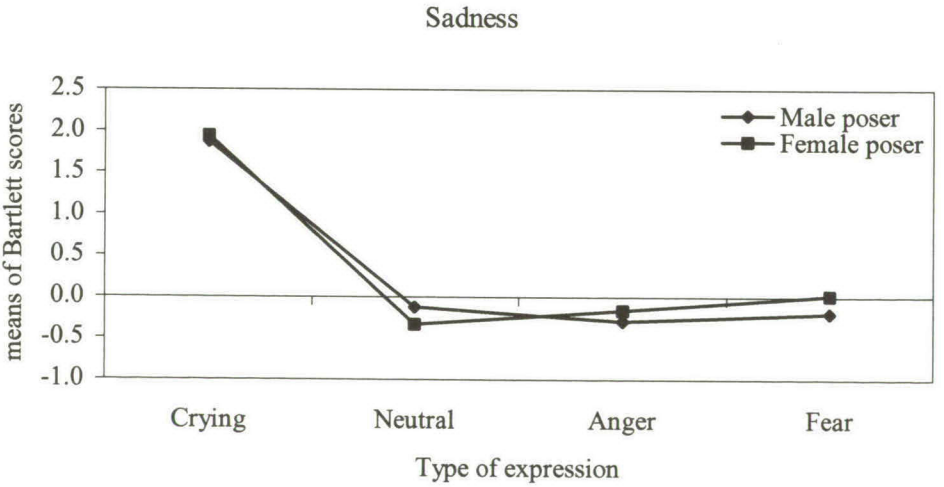


**Figure 5.** Means of the Bartlett scores on sadness for reactions to different types of facial expressions as a function of sex of the poser

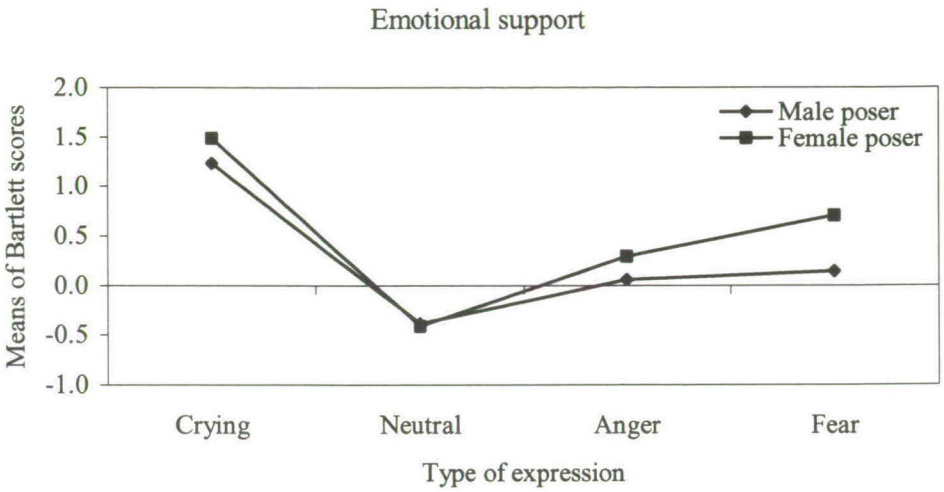


**Figure 6.** Means of the Bartlett scores on emotional support for reactions to different types of facial expressions as a function of sex of the poser

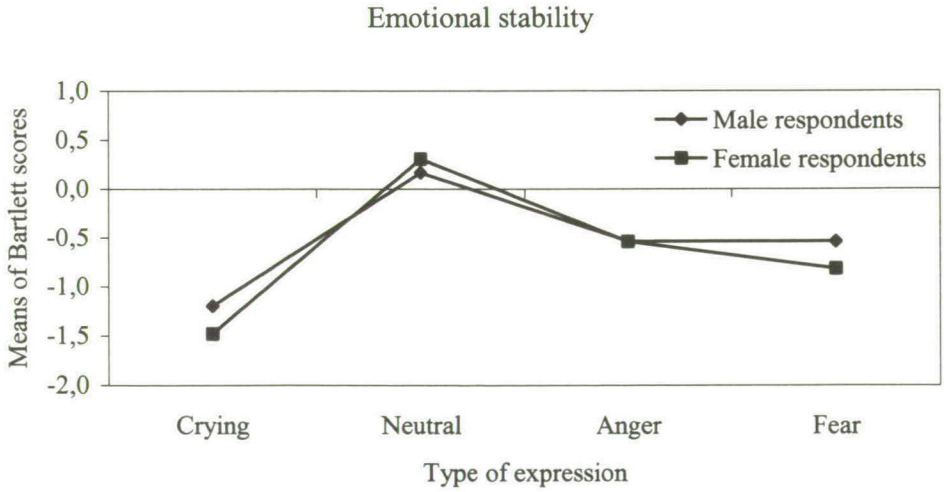


**Figure 7.** Means of the Bartlett scores on emotional stability for reactions to different types of facial expressions as a function of sex of the respondent

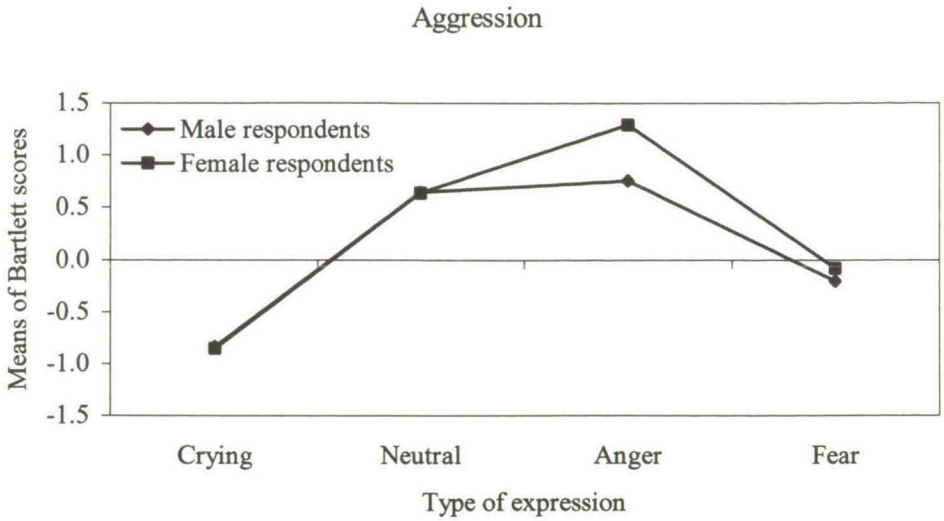


**Figure 8.** Means of the Bartlett scores on aggression for reactions to different types of facial expressions as a function of sex of the respondent

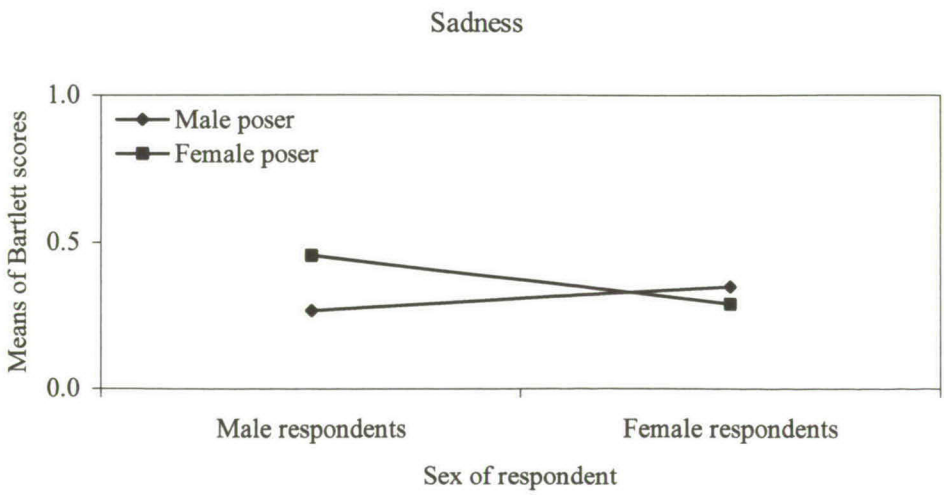


**Figure 9.** Means of the Bartlett scores on sadness as a function of sex of the respondent and sex of the poser

## DISCUSSION

The main objective of the present study was to explore the effects of different emotional facial expressions, including crying faces, on the person perception, experienced emotions and reported overt behavior of other people. In addition, the influence of the sex of the poser and of the sex of the observer on these social reactions was evaluated. The present study extended the knowledge of social reactions to facial expressions by (1) including crying expressions as stimuli, and (2) including reported overt behavior as dependent variable. In line with previous research on person perception (Hess et al., 2000; Knutson, 1996), our results demonstrated that people tend to attribute qualities to other people based on only a minimum of information, the facial expression depicted on a photo. In addition, following the studies on experienced emotions (Blairy et al., 1999; Hess & Blairy, 2001; Lundqvist & Dimberg, 1995), the type of facial expression partially determined which emotions the participants reported. The results also suggested that individuals tend to behave differently toward people dependent on their facial expression. Relative to the effects of the type of expression, the sex of the poser and the sex of the respondent only slightly influenced the social reactions to faces. Apparently, a particular facial expression elicits the same responses in men and in women, and regardless of whether a man or a woman made the expression.

As opted by several researchers (Frijda, 1997; Hess et al., 2000; Knutson, 1996), the post-hoc comparisons demonstrated that fearful faces were more similar to crying faces in terms of evoked social reactions than neutral and anger expressions. Compared to posers of neutral, anger and fear expressions, crying individuals were perceived as least emotionally stable and least aggressive, and elicited the most feelings of sadness. This is in accordance with the hypothesis that crying people would be perceived as less dominant and more affiliative than angry people, and that viewing crying faces would promote emotional contagion and/or empathy. Furthermore, compared to angry and fearful people, crying people were judged most passive and elicited the least feelings of discomfort in others. Concerning the reported overt behavior, it appeared that crying faces, compared to the other expressions, evoked the most emotional support, the least avoidance behavior and the fewest expressions of happiness in others. In other words, in line with Frijda (1997), crying people elicited more approach behavior than angry people. Furthermore, since adult tears elicited caretaking behavior such as attention, empathy and support in others (Cornelius & Lubliner, 2003; Fridlund, 1992; Frijda, 1997; Kottler & Montgomery, 2001; Nelson, 2000), crying can indeed be regarded as an important attachment behavior.

An interesting question is why people tend to emotionally support a crying person. A plausible answer is that the provided emotional support results from empathy with the crying individual. Batson et al. (1983), however, have demonstrated two different emotional responses to seeing another person suffer, namely empathy and personal distress. Possibly, the reduction of personal distress,

which might be regarded as an egoistic motivation to help, could also lie at the basis of the increased tendency to provide emotional support to crying people. In the present study, crying faces mainly elicited feelings of sadness and fewer feelings of discomfort and aversion, which indicates that the participants mainly felt empathy instead of personal distress and that participants thus most likely tended to help a crying person for altruistic reasons. However, in a study using vignettes, we showed that participants tended to help a crying person more than a non-crying person, while they at the same time reported more negative feelings (i.e., personal distress) and less sympathy in the presence of a crying than a non-crying person (Hendriks, Vingerhoets et al., submitted). Future research should therefore focus more explicitly on whether people help a crying person for egoistic or for altruistic reasons.

Looking at crying as attachment behavior provides a perspective for understanding the meaning of tears in the context of social relationships. While it is commonly assumed that crying is a clear and unambiguous phenomenon generally yielding the same reactions from the social environment, Nelson (1998, 2000), arguing from an attachment perspective, has distinguished two types of crying, namely *protest crying* and *sad crying*. The purpose of protest crying is to undo a loss and bring about a reunion (Bowlby, 1960). There is a lot of energy behind such a cry, and it is often accompanied by a hostile, negative, accusatory edge that can result in alienating potential caregivers. Crying of sad despair has more of a quiet energy and signifies the surrender to or acceptance of a loss. According to Nelson (1998, 2000), only sad crying arouses sympathetic responses in others, whereas protest crying is more likely to elicit irritation or apathy. Frijda (1986, 1997), Hill and Martin (1997) and Vingerhoets et al. (2000) have also acknowledged that tears in some instances may evoke frustration and irritation instead of empathy and support. Future research should therefore determine whether this distinction between types of crying is valid, and, if so, whether people respond differently to these kinds of crying. Additionally, one may speculate that the reactions of others to tears will depend on how they perceive the crying in terms of justified or not. Anecdotal evidence suggests that tears that are considered as inappropriate or manipulative may evoke strong negative reactions and even may be considered as blackmail (Frijda, 1997; Kottler, 1996).

A shortcoming of most of the previous studies (Blairy et al., 1999; Cornelius & Lubliner, 2003; Cornelius et al., 2000; Hess et al., 2000; Knutson, 1996; Lundqvist & Dimberg, 1995) and the present study as well is that posed instead of spontaneous facial expressions were used as stimuli. There is no guarantee that these posed facial expressions are encountered in real everyday life. While in the present study the posers were not guided by the experimenter as to how to pose a certain expression, posed expressions might be exaggerated or stylized in a manner that the expressions are most likely to be understood by observers (Russell, 1994). As a consequence, the differences in social reactions to

the different facial expressions might have been more pronounced at the expense of the influence of the sex of the poser and the sex of the respondent on these social reactions.

Furthermore, in all the studies (Blairy et al., 1999; Cornelius & Lubliner, 2003; Cornelius et al., 2000; Hess & Blairy, 2001; Hess et al., 2000; Knutson, 1996; Lundqvist & Dimberg, 1995) including the present, participants had to base their responses on a minimum of information, a facial expression. In real life, people usually have a wider variety of sources of information at their disposal such as nonverbal cues (e.g., body posture), verbal cues and, in particular, situational cues. According to Fernández-Dols (1999) and Carroll and Russell (1996), the context of a facial expression is important in determining the meaning of the expression. There is no reason to assume that the context (in particular whether the expressed emotion is perceived as appropriate or not) does not also influences the social reactions to facial expressions. Accordingly, Hendriks, Vingerhoets et al. (submitted) demonstrated that the reactions from the social environment to crying were partially determined by the situation in which the person cried.

Finally, the present study did not contain sad faces without tears or crying faces with the tears digitally removed as stimuli. As mentioned before, crying and sad faces both seem to communicate the message that one is feeling sad and in need of help (Cornelius & Lubliner, 2003; Cornelius et al., 2000; Yik & Russell, 1999). The data of Cornelius and his colleagues (Cornelius & Lubliner, 2003; Cornelius et al., 2000), however, suggest that tearful faces and the same faces with the tears digitally removed may elicit some intriguing different social reactions. It would be interesting to find out whether crying faces are a more compelling help-soliciting signal than sad faces without tears. This would imply that tears are an essential component in eliciting caretaking behavior in others and that putting up a sad face does not suffice. Averill (1968) and Bell and Ainsworth (1972) have suggested that the power of crying to elicit proximity more effectively than any other signaling behavior can be mainly ascribed to its ability to arouse displeasure or alarm in others.

In sum, since research until now has only asked participants to rate posed expressions in an experimental situation devoid of other information sources, it can only answer the question what kind of social reactions facial expressions *can* elicit, and not what kind of social reactions they typically *do* elicit in real life (Ekman, 1993). Future research should therefore examine the social reactions to more ambiguous and spontaneous faces that are expressed in several contexts, preferably in real-life settings. In addition, it would be interesting to find out whether people also respond differently to different kinds of facial expressions in terms of psychophysiological reactions such as heart rate, blood pressure and electroencephalographic activity. Nonetheless, the present study showed that crying, neutral, anger and fear expressions elicited different reactions from the social environment, also in terms of reported overt behavior. Apparently, facial

expressions influence other people persuasively and therefore probably play a crucial role in everyday social interactions. Most importantly, the present study demonstrated that crying is a very compelling communicative signal with a high potential to elicit empathy and emotional support. Our results support the idea that crying is an important attachment behavior throughout life, not just during childhood, which is primarily meant and used to stimulate others to offer comfort and help.

# CHAPTER 6
# An ERP study on the implicit processing of crying faces*

## INTRODUCTION

Facial expressions are important communicative signals in everyday social interactions. An expressing individual is thought to provide information about his/her emotional state with the aim to change the social environment and to elicit or inhibit particular behaviors in other people (Fridlund, 1992). Research has yielded that different aspects of faces are processed in separate neural subsystems, and that the brain has developed specific processes for perceiving and recognizing facial expressions (e.g., Batty & Taylor, 2003; Haxby, Hoffman, & Gobbini, 2002; Krolak-Salmon, Fischer, Vighetto, & Mauguière, 2001; Posamentier & Abdi, 2003). For instance, selective impairments have been reported in which an individual is able to identify people but cannot recognize their facial expression (e.g., Adolphs, Damasio, Tranel, & Damasio, 1996; Adolphs, Tranel, Damasio, & Damasio, 1994; Young, Newcombe, De Haan, Small, & Hay, 1993).

Given that the recognition of facial expressions is one of the most relevant communication skills in humans, it may be expected that information about emotional states are processed rapidly and accurately to be available for the on-line regulation of social behavior (Eimer & Holmes, 2002). Until present, the temporal aspects of the processing of facial expressions have, however, received little scientific attention. Crying, although considered as a powerful signal in communication (Cornelius & Labott, 2001; Kottler, 1996), has never been included in these studies. The objective of the present study was to examine event-related potentials (ERP) in reaction to different facial expressions, including crying faces.

Crying is a common and uniquely human form of emotional expression that is characterized by the shedding of tears, changes in facial expression and vocalizations (Patel, 1993). While no other species has the ability to shed emotional tears, people of all ages and from all cultures cry on certain occasions to express their emotions (Vingerhoets & Cornelius, 2001). Kottler (1996) speculated that crying is uniquely human because humans develop relatively slow and therefore for a considerably long time need the help of others to take care of them.

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* Hendriks, M. C. P., Van Boxtel, G. J. M., & Vingerhoets, A. J. J. M. (submitted). An ERP study on the implicit processing of crying faces.

According to social-psychological theories, crying is an expressive display, which is hard to ignore and whose primary function is to communicate to others in an unambiguous way that one is vulnerable, suffering and/or in need of aid (Fridlund, 1992; Frijda, 1997; Kottler & Montgomery, 2001). As shown by attachment theory and research, crying is an inborn behavior that functions throughout life to call for and assure the protective and nurturing presence of caregivers (Bowlby, 1969; Zeifman, 2001).

Behavioral research on the social reactions to crying faces has demonstrated that crying individuals were rated as more emotional, more sad and less aggressive than individuals with the same expression but with the tears digitally removed (Cornelius et al., 2000) and than individuals with neutral, anger and fear expressions (Hendriks & Vingerhoets, submitted). In addition, crying faces elicited the most feelings of sadness (Hendriks & Vingerhoets, submitted), and participants thought that crying people mainly communicated the message that they want help, comfort or taken care of (Cornelius & Lubliner, 2003; Cornelius et al., 2000). Crying faces also elicited strong behavioral reactions. Compared to other expressions such as anger and fear, they evoked the most emotional support and the least avoidance behavior (Cornelius & Lubliner, 2003; Hendriks & Vingerhoets, submitted). These results are in accordance with the supposed help-soliciting function of crying and suggest that crying is a compelling expressive display that is important for social bonding and human survival. It therefore would be interesting to examine whether crying faces are processed by different parts of the brain and/or with a different time course than other facial emotional expressions.

In their theoretical model on face recognition, Bruce and Young (1998) have described several distinct types of information that can be derived from faces. In early stages, structural encoding processes lead to descriptions of the presented face in terms of the global configuration and features. Additionally, Bruce and Young (1998) suggested the existence of an 'expression code' implicated in the decoding of emotional facial expressions. Concerning the anatomical location of these processes, Haxby et al. (2002) have proposed a distributed neural system involved in face perception. The core structures of this system are the inferior occipital gyri, the lateral fusiform gyrus and the superior temporal sulcus. The inferior occipital gyri supposedly provide input to the other two regions, and are mostly associated with the early perception of facial features. The fusiform gyrus is considered a module for the perception of invariant aspects of faces, whereas the superior temporal sulcus is proposed to be involved in the perception of facial expression. More noteworthy, both Bruce and Young (1998) and Haxby et al. (2002) have claimed that the facial configuration and emotional facial expression are processed independently.

In accordance with the model of Bruce and Young (1998), electroencephalographic (EEG) research has demonstrated two early face-specific

ERP components in the range between 120 and 175 ms after stimulus onset, namely a bilateral occipito-temporal negativity (N170; Posamentier & Abdi, 2003) and a vertex-positive potential (VPP; Herrmann et al., 2002). These components have been linked to the precategorical structural encoding of faces, and are considered to reflect the dissociation between the processing of face and non-face stimuli (Posamentier & Abdi, 2003). However, ERP modulations sensitive to the nature of the expressed emotion on the face have been found as early as 90 ms post-stimulus (Batty & Taylor, 2003), and it therefore remains to been seen whether the face-specific N170 and VPP are unaffected by emotional expressions. Although most ERP studies showed that the type of facial expression did not influence the N170 (Eimer & Holmes, 2002; Eimer, Holmes, & McGlone, 2003; Holmes, Vuilleumier, & Eimer, 2003; Krolak-Salmon et al., 2001), Batty and Taylor (2003) and Stekelenburg and De Gelder (2004) did demonstrate emotion-modulation effects. More specifically, the study of Batty and Taylor (2003) revealed that the latency of the N170 was longer in response to fearful, disgusting and sad faces than in response to neutral, happy and surprised faces, and that fear faces evoked a N170 with higher amplitude than any of the other facial expressions. Stekelenburg and De Gelder (2004) showed that the N170 measured in the left occipito-temporal area was more negative for fear expressions than for neutral expressions. Concerning the VPP, the studies of (Herrmann et al., 2002; Krolak-Salmon et al., 2001) revealed that this component was not affected by the emotion expressed on faces.

So far, only one study has examined the processing of crying faces. Donkers, Van Boxtel, and Vingerhoets (2001) showed that the VPP did not vary in reaction to neutral adult faces, crying adult faces and neutral faces of babies. Unfortunately, they did not compare the ERP correlates evoked by crying faces with the ERP correlates evoked by other emotional expressions. More research has been performed on the processing of the auditory component of crying (e.g., Purhonen, Pääkkönen, Yppärilä, Lehtonen, & Karhu, 2001; Sander & Scheich, 2001; Seifritz et al., 2003). Purhonen et al. (2001), for instance, revealed that the auditory N100 habituated faster and had longer latencies during presentations of a cry stimulus than during presentations of the Finnish word for 'hi'. They postulated that these results reflect the slower processing and more persistent memory of emotional than neutral stimuli. In their fMRI study, Sander and Scheich (2001) demonstrated that compared with silence both adult laughing and adult crying activated the amygdala and insula bilaterally suggesting that these structures are involved in the perception of emotionally relevant stimuli.

To summarize, previous ERP studies on responses to emotional face stimuli were mostly in accordance with the models of Bruce and Young (1998) and of Haxby et al. (2002) in suggesting that the structural encoding of faces and the processing of emotional expression are parallel and independent processes. An important shortcoming of these studies, however, is that they have only considered

the ERP correlates of the face processing of expressions of basic emotions. Since we are exposed to a whole range of facial expressions in our everyday life, it is important to find out whether ERPs elicited by the expressions of basic emotions differ from those elicited by other facial expressions. More importantly, crying expressions have almost never been included in ERP studies on face processing and the one study that did (Donkers et al., 2001) did not include other emotional facial expressions.

Therefore, the objective of the present study was to determine whether the characteristics of the N170 and VPP evoked by crying expressions differed from those evoked by expressions of basic emotions. Participants viewed photographs of faces depicting six different facial expressions, namely neutral, crying, non-crying (i.e., crying faces with the tears digitally removed), angry, fearful and laughing, and meanwhile performed a sex-discrimination task. We opted for an implicit face-processing task to ensure that possible differences in ERP correlates were not due to directed attention but were only attributable to emotional processing (Batty & Taylor, 2003; Sato, Kochiyama, Yoshikawa, & Matsumara, 2001). Based on the study of Batty and Taylor (2003), we expected that the implicit processing of facial expressions would start before the onset of the N170 and VPP and that the face-specific components would be modulated in terms of latency and amplitude by the emotion expressed on faces. Based on the findings that crying is a compelling communicative signal that elicits strong behavioral reactions in others, we reasoned that crying faces would be processed differently than the other facial expressions. That is, we hypothesized that the latency and amplitude of the N170 and VPP elicited by crying faces would differ from the latency and amplitude of these ERP components evoked by other expressions.

## METHOD

### Participants

Twenty-six first-year psychology students, who received course credit for participation, took part in the present study. Data of one person had to be excluded due to malfunction of one of the electrooculograph (EOG) electrodes. The final group consisted of five men aged from 18 up to 24 years old ($M$ = 19.4, $SD$ = 2.6), and of 20 women aged from 18 up to 23 years old ($M$ = 19.8, $SD$ = 1.8). As measured by the Edinburgh Handedness Inventory (Oldfield, 1971), one person was left-handed and all others were right-handed. All participants had normal or corrected-to-normal vision.

### Stimulus material

Color photographs were taken from faces of 10 men and 19 women adopting the following expressions: neutral, yawning, sticking tongue out, smiling, laughing, anger, fear and crying (tears were elicited with eye drops). The resulting set of 232 photographs were rated by 200 individuals who indicated in their own words which

emotion or gesture each face expressed. In the present study, only photographs of neutral, crying, anger, fear and laughing expressions were used as stimuli. The photographs of four men and four women that were recognized best by the 200 individuals were selected. In addition, for the present study, so-called non-crying faces were produced by digitally removing the tears of the crying faces. Ultimately, this resulted in a total of 48 photographs, which appeared on a computer screen in front of a black background at 12.3 inch (31.3 cm) wide and 8.3 inch (21.0 cm) tall with a resolution of 72 pixels per inch (28.3 pixels per cm). Between stimuli, a white fixation point was presented on the center of the screen.

**Procedure**

Participants were individually seated in a soundproof cabin with the computer screen at a viewing distance of 110 cm. The experiment consisted of two delayed-response tasks. In the first task, the participants had to indicate with a left-hand or right-hand button press whether the person on the photograph was a man or a woman (sex discrimination). The second task was an emotion-discrimination task; participants had to indicate with a left-hand or right-hand button press whether the person on the photograph was happy or not. Because we were mainly interested in the implicit processing of facial expressions, the sex-discrimination task was always performed before the emotion-discrimination task. Given this focus, only the results of the sex-discrimination task will be reported in the present article. It was counterbalanced across participants which hand participants were instructed to use to indicate whether the person on the photograph was a man or a woman.

During the sex-discrimination task, all photographs were repeated eight times, resulting in 384 trials. Trials were randomly presented with the restriction of immediate stimulus repetitions. On each trial, the stimulus was presented for 500 ms. A delayed response was given to lower the risk of the ERPs being contaminated by motor activity; 1000 ms after stimulus onset a response panel appeared on the screen for 1000 ms indicating that the participant should give his/her response. The interval between two successive stimulus presentations varied randomly between 2000 ms and 3000 ms in steps of 200 ms. Prior to the task, the participant was familiarized with the procedure in six training trials during which the participants rated photographs that were not included in the main task.

After completing the delayed-response tasks, participants were asked to rate the arousal and valence of each facial expression on a 9-points Likert-scale varying from calm to excited and from unpleasant to pleasant, respectively. In addition, they had to identify the emotion that the person on the photo expressed by choosing one of the following options: neutral, angry, astonished, happy, aversion, sad, bored, fearful or other.

**Electrophysiological recording and analysis**

During the sex-discrimination task, the electroencephalograph (EEG) was recorded monopolarly from 49 locations using sintered Ag-AgCl electrodes (Biosemi ActiveTwo) mounted in an elastic cap. Horizontal and vertical EOG-electrodes monitored the eye movements. The horizontal electrodes were placed on the outer canthi of both eyes and the vertical electrodes were placed in line with the pupil on the infraorbital and supraorbital regions of the left eye. The EEG and EOG signals were sampled at a rate of 256 Hz, and off-line re-referenced to an averaged reference.

The continuous EEG recordings were band-pass filtered (0.16-30 Hz, 24 dB/octave) and segmented into epochs of 1100 ms including a 100 ms prestimulus baseline for each type of facial expression separately. Eye-blink and eye-movement artifacts were treated using the EOG artifact-correction procedure proposed by Gratton, Coles, and Donchin (1983). Additionally, for each electrode, individual segments with an amplitude change exceeding 100 μV were automatically rejected. Next, the EEG was averaged relative to the 100 ms baseline preceding stimulus onset. Separate averages were computed for each type of facial expression, resulting in six average waveforms for each electrode and participant.

## RESULTS

**Behavioral results**

Figures 1 and 2 depict the mean ratings of arousal and valence ascribed to the different types of facial expressions. The type of expression influenced both the rated arousal and the rated valence (both $F(5, 20)$s > 31.26, $p$s < .001, *partial* $\eta^2$s > .88). Neutral expressions received lower ratings of arousal than the emotional expressions (all $F(1, 25)$s > 92.89, $p$s < .001, *partial* $\eta^2$s > .69). Crying faces received lower ratings of arousal than laughing and fearful faces (both $F(1, 25)$s > 14.59, $p$s < .01, *partial* $\eta^2$s > .37), and higher ratings of arousal than neutral, angry and non-crying faces (all $F(1, 25)$s > 4.80, $p$s < .05, *partial* $\eta^2$s > .16). Concerning valence, neutral expressions were rated near to the midpoint of 5 (i.e., neutral), and were rated less pleasant than laughing expressions ($F(1, 25) = 538.87$, $p < .001$, *partial* $\eta^2 = .96$), and less unpleasant than the other emotional expressions (all $F(1, 25)$s > 63.25, $p$s < .001, *partial* $\eta^2$s > .72). Moreover, crying faces were rated more unpleasant than any of the other expressions (all $F(1, 25)$s > 6.34, $p$s < .05, *partial* $\eta^2$s > .20).

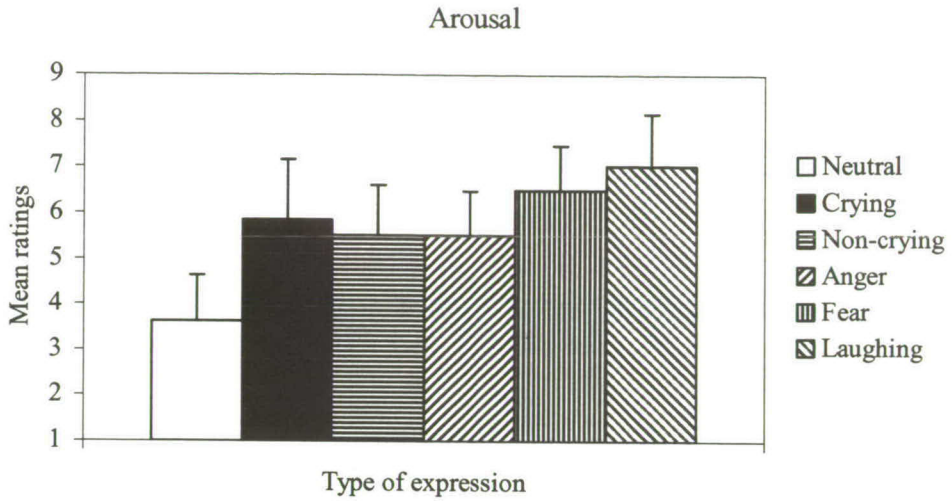



**Figure 1.** Mean ratings on arousal as a function of type of facial expression

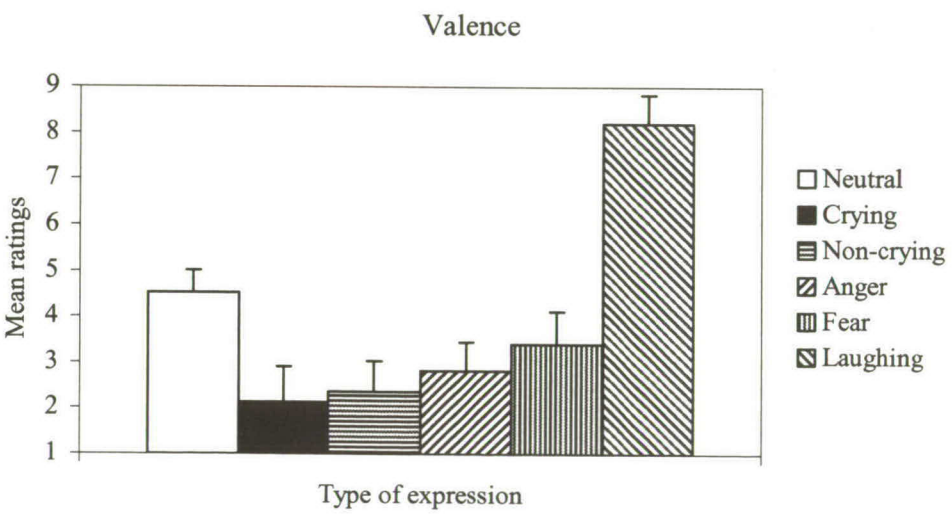



**Figure 2.** Mean ratings on valence as a function of type of facial expression

Additionally, the participants identified the emotion that the posers expressed. It appeared that neutral expressions were labeled neutral in 63.6% of the cases; laughing expressions were labeled happy in 99.5% of the cases; anger expressions were labeled angry in 54.2% of the cases; fear expressions were labeled fearful in 32.2% of the cases and astonished in 49.3% of the cases; crying expressions were labeled sad in 91.3% of the cases; and non-crying expressions were labeled sad in 85.0% of the cases.

**Task performance**

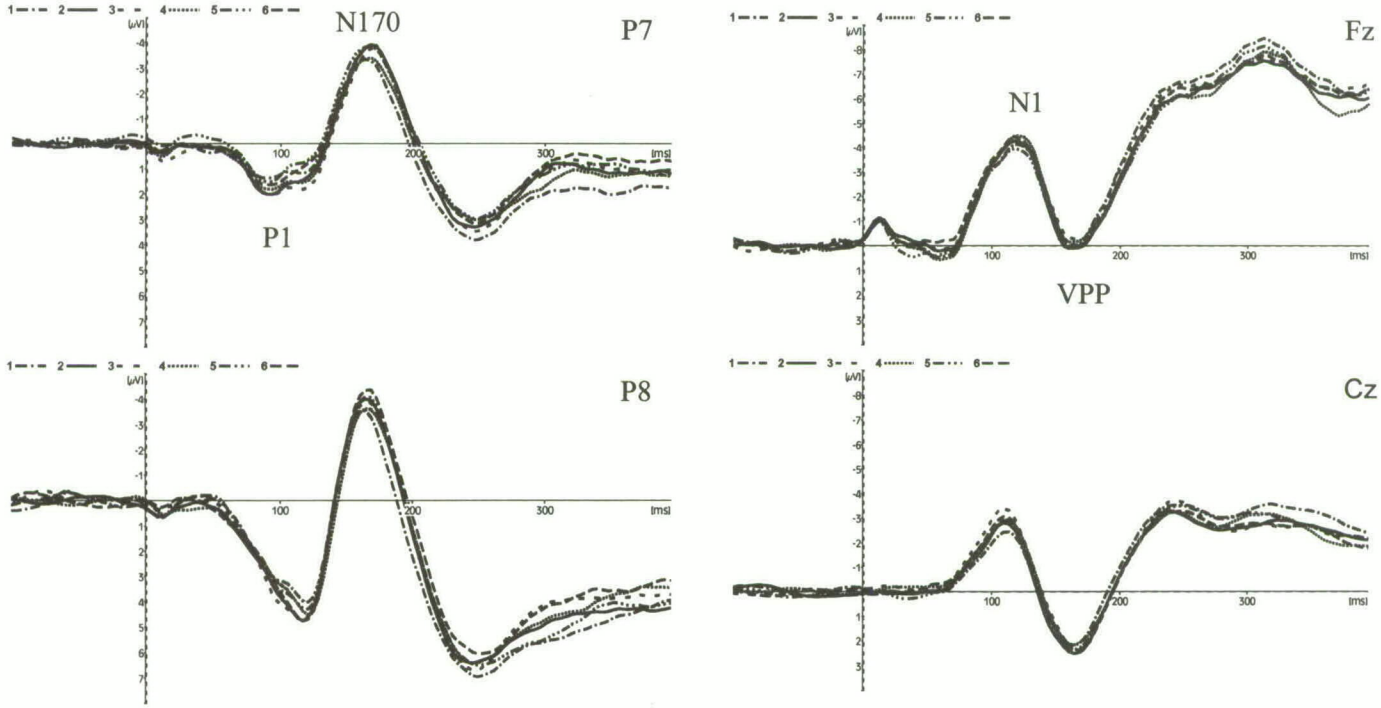
All 25 participants performed the sex-discrimination task with a high level of accuracy. The average percentage of correctly classified stimuli was not influenced by the type of expression ($F(5, 20) = 1.07$, $p = .41$, *partial* $\eta^2 = .21$), and varied between 99.3% for fear expressions and 99.8% for crying expressions.

**Electrophysiological results**

Figure 3 presents the grand-averaged ERPs obtained in the sex-discrimination task in response to the different types of facial expressions. In the occipito-temporal areas, the first positive peak (P1) was recorded with a mean latency of 115 ms (*mean amplitude* = 2.72 μV at P7 and 5.64 μV at P8) and this peak was associated with a mid-frontal negativity (N1) at around 114 ms (*mean amplitude* = -5.18 μV at Fz and -3.56 μV at Cz). The N170 was observed in the occipito-temporal regions around 165 ms (*mean amplitude* = -4.61 μV at P7 and –5.22 μV at P8) and its positive counterpart, the VPP, was recorded by the midline electrodes at a mean latency of 167 ms (*mean amplitude* = 0.79 μV at Fz and 3.14 μV at Cz). These four ERP components were evoked by all the different facial expressions and the six ERP profiles looked very similar on visual inspection. The question remained whether the evoked N170 and VPP differed for the different types of facial expressions in terms of mean latency and mean amplitude.

Since the N170 was most prominent at P7 and P8 and the VPP was most prominent at Cz and Fz, we just analyzed the values derived from these electrode positions. For each electrode position, separate repeated measures analyses of variance were performed on the peak amplitudes and peak latencies of the N170 and of the VPP with type of facial expression as a within-subjects factor. Given our focus on crying, all repeated measures analyses were followed by post-hoc analyses comparing the ERP correlates of crying expressions with the ERP correlates of every other facial expression. As recommended by Keselman (1998), the results of the multivariate approach of the ANOVAs will be reported.

**Figure 3.** Grand-averaged ERPs obtained in the sex-discrimination task as function of type of expression (1 = neutral, 2 = crying, 3 = non-crying, 4 = angry, 5 = fearful and 6 = happy faces)



*Peak N170*

Repeated measure analyses on the N170 latency revealed that the peak latency varied with type of facial expression at P7 ($F(5, 20) = 2.98$, $p < .05$, *partial* $\eta^2 = .43$), and was longer for crying expressions than for fear expressions ($F(1, 24) = 5.75$, $p < .05$, *partial* $\eta^2 = .19$; see Figure 4). The latency at P7 for crying expressions did not differ from those for the other four expressions (all $F(1, 24)$s < 1.92, $p$s > .17, *partial* $\eta^2$s < .08), and no significant effects were found for the peak latency at the P8 site ($F(5, 20) = 1.26$, $p = .32$, *partial* $\eta^2 = .24$ and $F(1, 24)$s < 1.26, $p$s > .30, *partial* $\eta^2$s < .05). Concerning the N170 amplitude, it appeared that the type of facial expression did not modulate the amplitude at P7 or P8 (both $F(5, 20)$s < 1.57, $p$s > .21, *partial* $\eta^2$s < .29), and that crying faces did not differ from any of the other faces (all $F(1, 24)$s < 3.72, $p$s > .06, *partial* $\eta^2$s < .14).

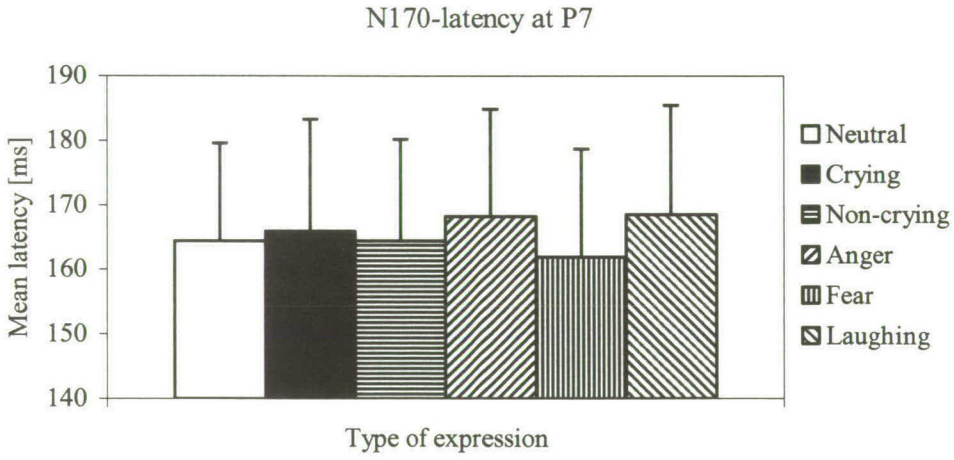



**Figure 4.** Mean N170-latency at electrode position P7 as a function of type of facial expression

*Peak VPP*

No significant differences were found between the different types of facial expressions concerning the latency or amplitude of the VPP at Fz or Cz (both $F(5, 20)$s < 0.92, $p$s > .49, *partial* $\eta^2$s < .19). In addition, crying faces did not elicit a different VPP in terms of latency or amplitude than the other types of faces (all $F(1, 24)$s < 2.78, $p$s > .10, *partial* $\eta^2$s < .11).

In short, the type of facial expression only modulated the N170 latency in the left occipito-temporal area, where crying expressions were processed more slowly than fear expressions.

To further determine whether the type of facial expression affected the N170 and VPP, we conducted a second set of repeated measures analyses. In this set, the amplitudes and latencies of the N170 and VPP were corrected for the amplitudes and latencies of the preceding peaks P1 and N1, respectively. This procedure was allowed, because the type of facial expression hardly influenced the peak amplitudes and peak latencies of the P1 and N1 (Picton et al., 2000). For each electrode position, separate repeated measures analyses of variance were performed on the peak-to-peak amplitudes and peak-to-peak latencies with type of facial expression as a within-subjects factor. Again, all repeated measures analyses were followed by post-hoc analyses comparing the ERP correlates of crying expressions with the ERP correlates of every other facial expression.

*Peak N170-to-peak P1*

It appeared that the type of facial expression did not influence the peak-to-peak latency at the P7 and P8 sites (both $F(5, 20)$s $< 1.57$, $p$s $> .21$, *partial* $\eta^2$s $< .29$). Crying faces had a longer peak-to-peak latency than the same faces with the tears removed at electrode position P7 ($F(1, 24) = 4.81$, $p < .05$, *partial* $\eta^2 = .17$; see Figure 5), and than neutral faces at electrode position P8 ($F(1, 24) = 4.44$, $p < .05$, *partial* $\eta^2 = .16$; see Figure 6). The remaining post-hoc comparisons were not significant (all $F(1, 24)$s $< 2.87$, $p$s $> .10$, *partial* $\eta^2$s $< .11$).

Figure 7 and 8 show that the peak-to-peak amplitude varied with type of facial expression at electrode positions P7 ($F(5, 20)$s $= 2.78$, $p < .05$, *partial* $\eta^2 = .41$) and P8 ($F(5, 20) = 4.06$, $p < .05$, *partial* $\eta^2 = .50$). In both instances, crying expressions evoked a more negative N170 than neutral expressions ($F(1, 24) = 7.42$, $p < .05$, *partial* $\eta^2 = .24$ and $F(1, 24) = 8.52$, $p < .01$, *partial* $\eta^2 = .26$, respectively). At P7, the peak-to-peak amplitude was higher for crying faces than for fear faces ($F(1, 24) = 8.67$, $p < .01$, *partial* $\eta^2 = .27$). Other post-hoc comparisons did not reach the level of significance (all $F(1, 24)$s $< 3.42$, $p$s $> .07$, *partial* $\eta^2$s $< .13$).

*Peak VPP-to-peak N1*

The repeated measures analyses revealed that the peak-to-peak latency did not differ depending on facial expression at both Fz and Cz (both $F(5, 20)$s $< 1.31$, $p$s $> .29$, *partial* $\eta^2$s $< .25$). At the Cz site, crying faces had a longer peak-to-peak latency than neutral faces ($F(1, 24) = 5.37$, $p < .05$, *partial* $\eta^2 = .18$; see Figure 9). The other post-hoc comparisons were not significant (all $F(1, 24)$s $< 2.78$, $p$s $> .11$, *partial* $\eta^2$s $< .11$).

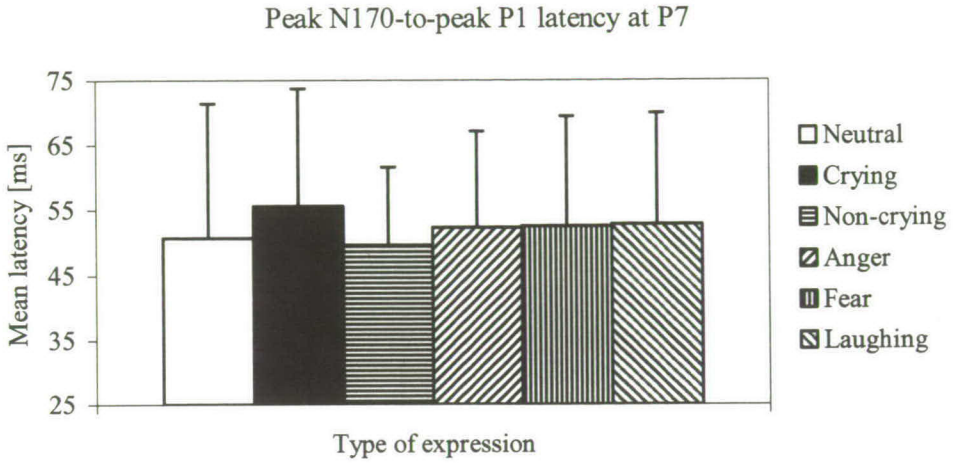



**Figure 5.** Mean latency of the peak N170-to-peak P1 at P7 as a function of type of facial expression

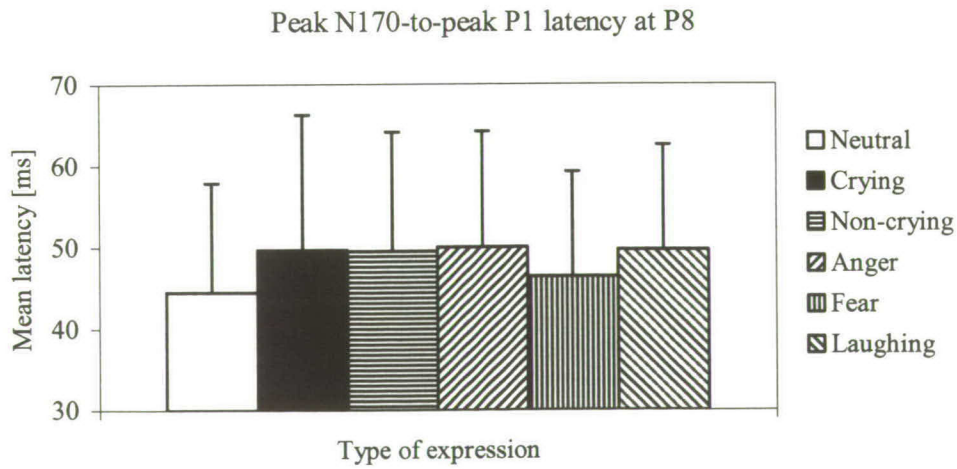



**Figure 6.** Mean latency of the peak N170-to-peak P1 at P8 as a function of type of facial expression

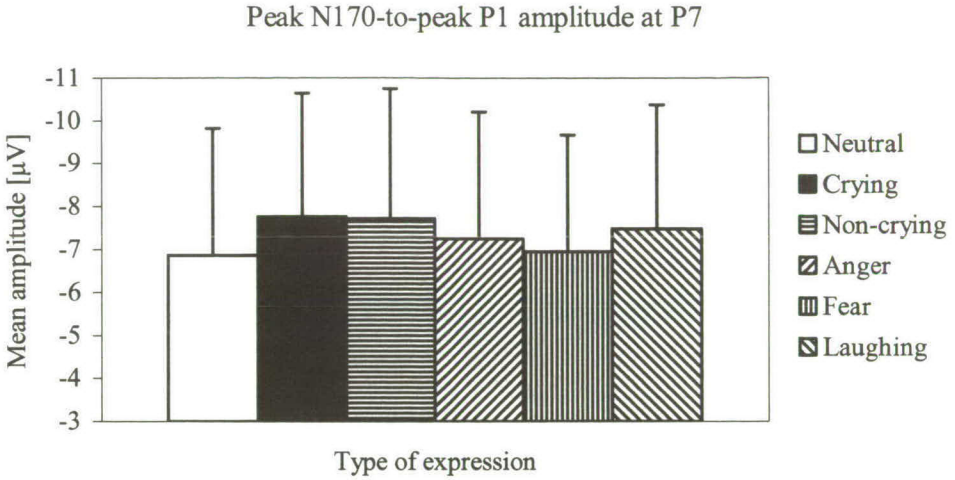



**Figure 7.** Mean amplitude of the peak N170-to-peak P1 at P7 as a function of type of facial expression

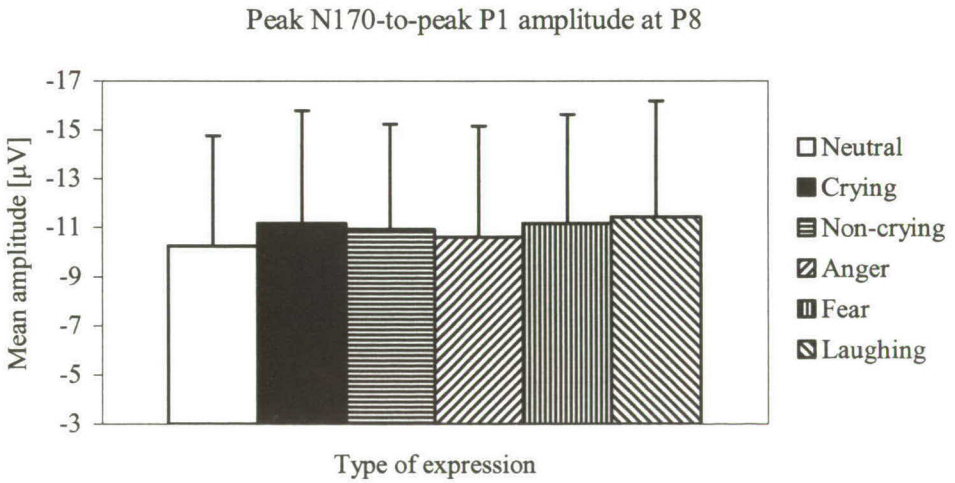



**Figure 8.** Mean amplitude of the peak N170-to-peak P1 at P8 as a function of type of facial expression

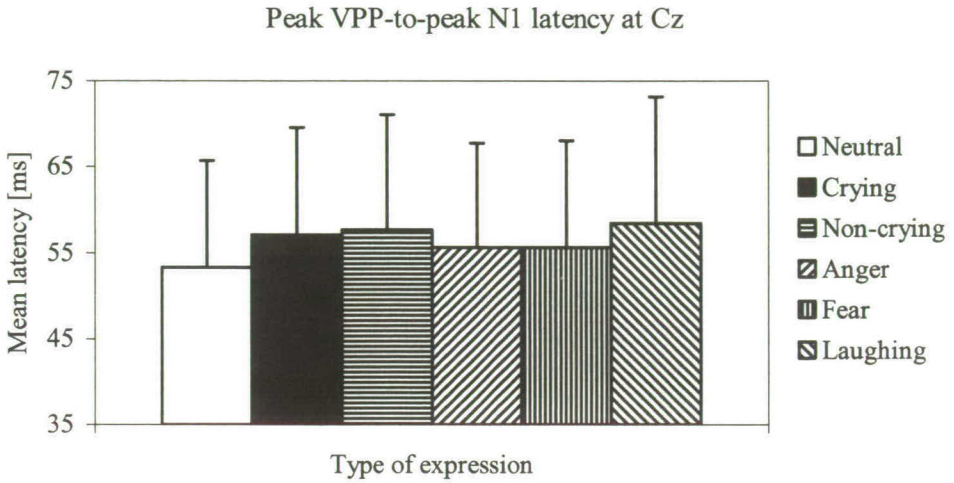



**Figure 9.** Peak VPP-to-peak N1 latency at Cz as a function of type of facial expression

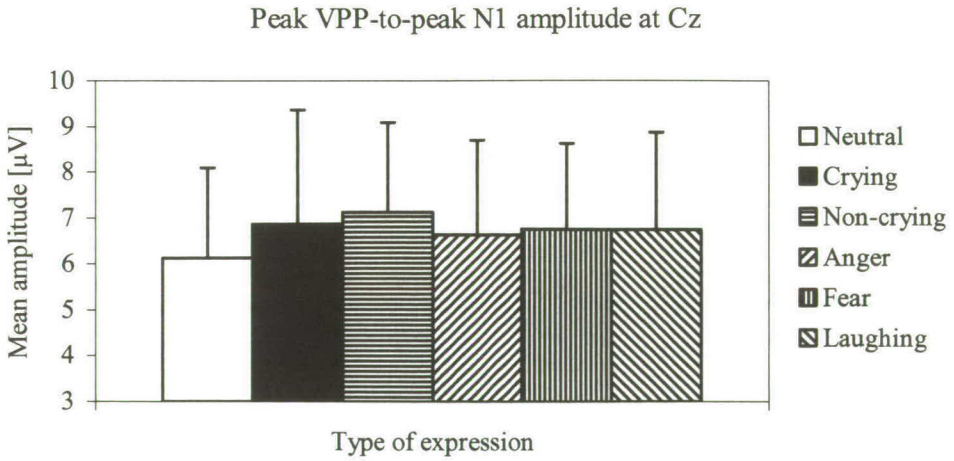



**Figure 10.** Peak VPP-to-peak N1 amplitude at Cz as a function of type of facial expression

At electrode position Cz, the peak-to-peak amplitude varied with type of facial expression ($F(5, 20) = 5.36$, $p < .01$, *partial* $\eta^2 = .57$), and was higher for crying faces than for neutral faces ($F(1, 24) = 12.19$, $p < .01$, *partial* $\eta^2 = .34$; see Figure 10). No main effect of type of expression was found at the Fz site ($F(5, 20) = 0.56$, $p = .72$, *partial* $\eta^2 = .12$), and crying expressions did not differ from any of the other expressions at both Cz and Fz (all $F(1, 24)$s $< 1.82$, $ps > .19$, *partial* $\eta^2$s $< .08$).

In sum, the results revealed that crying expressions evoked longer peak-to-peak latencies than non-crying faces in the left occipito-temporal area and than neutral faces in the right occipito-temporal area and at vertex. Crying faces additionally elicited a higher peak-to-peak amplitude than neutral faces in both left and right occipito-temporal areas and at vertex, and a higher peak-to-peak amplitude than fearful faces in the left occipito-temporal area.

*Effects of rated arousal and valence*

Since Cuthbert, Schupp, Bradley, Birbaumer, and Lang (2000) and Lang, Greenwald, Bradley, and Hamm (1993) have suggested that judgments of affective valence and arousal correlate with processes in the brain, we wanted to find out whether variations in ERP waveforms elicited by the different facial expressions were partially determined by the valence and arousal ascribed to the faces. The same repeated measures analyses were performed on the peak-to-peak measures, but now with the rated arousal and valence taken one at a time as a covariate. The results revealed that arousal did not in any case adjust the main effect of type of facial expressions (all $t$s $< |1.78|$, $ps > .08$, $\eta^2$s $< .13$). Valence modified the main effect of type of facial expression for the peak N170-to-peak P1 latency at both P7 ($t = 2.72$, $p < .05$, $\eta^2 = .24$) and P8 ($t = 3.09$, $p < .01$, $\eta^2 = .29$), and the peak VPP-to-peak N1 latency at Fz ($t = 2.09$, $p < .05$, $\eta^2 = .16$). In the other analyses, valence did not attenuate the main effect of type of facial expression (all $t$s $< |1.42|$, $ps > .16$, $\eta^2$s $< .09$). In other words, the rated arousal and valence did not strongly influence the evoked ERP waveforms.

## DISCUSSION

In the present study, we examined the ERP correlates evoked during the implicit processing of different facial expressions and focused on the characteristics of the face-specific components N170 and VPP. The major aim was to extend previous ERP findings by including crying faces as stimuli. Crying is an important communicative signal that elicits strong behavioral reactions in others. For example, in two previous studies, we demonstrated that crying has a major and distinct impact on how a person is perceived and responded to (Hendriks & Vingerhoets, submitted; Hendriks, Vingerhoets, & Croon, unpublished work). In

the present study, we wanted to determine whether also the ERP waveforms elicited by crying expressions differed from those evoked by other expressions. It appeared that all face stimuli evoked the bilateral occipito-temporal negativity N170 and the vertex-positive potential VPP, but that the type of facial expression modulated the latency and amplitude of these components. More importantly, the ERP correlates for crying faces differed mostly from those for neutral faces and not from those for the other emotional faces.

Our findings suggest that the structural encoding of faces and the processing of emotional expression are not totally independent processes as assumed by Bruce and Young (1998) and by Haxby et al. (2002). In contrast to most previous studies (Donkers et al., 2001; Eimer & Holmes, 2002; Eimer et al., 2003; Herrmann et al., 2002; Holmes et al., 2003; Krolak-Salmon et al., 2001), the present results revealed that both the N170 and VPP were modulated by the emotion expressed on the face stimuli. Since it is well-known that the task at hand can influence perceptual processing, a possible explanation for this discrepancy is the use of different task instructions. Based on LeDoux's (1996) concept of 'low and high roads', it can be postulated that implicit-processing tasks only demand a crude presentation of the stimuli ('low road'), whereas explicit-processing tasks entail a more elaborated processing ('high road; Posamentier & Abdi, 2003)'. Eimer et al. (2003) proposed that the demand for explicit emotion-recognition might delay the onset of emotional expression effects. The present study and all previous studies that found differences in the N170 and VPP (Batty & Taylor, 2003; Stekelenburg & De Gelder, 2004) had the participants perform an implicit-processing task, which might explain the presence of the early emotion effects. However, some of the studies that failed to find any emotion effects on the N170 and VPP also employed an implicit-processing task (Eimer & Holmes, 2002; Eimer et al., 2003; Herrmann et al., 2002; Holmes et al., 2003; Krolak-Salmon et al., 2001). It would therefore be interesting to find out in future studies whether more subtle differences in task instructions can explain these inconsistent findings.

Alternatively, the role of habituation might not have been equally great in the different ERP studies. According to Eimer et al. (2003), the repeated exposure to a specific emotional expression may result in the gradual habituation of emotion-specific responses. Most previous studies (Eimer & Holmes, 2002; Eimer et al., 2003; Herrmann et al., 2002; Holmes et al., 2003; Krolak-Salmon et al., 2001) used the widely used and known set of facial expressions compiled by Ekman and Friesen (1976) and most of them (except for Krolak-Salmon et al., 2001) compared the ERP correlates evoked by neutral expressions only with those evoked by one or two basic emotions. This might have concealed possible differences in ERP correlates in response to different emotional facial expressions. In contrast, both Batty and Taylor (2003) and the present study used a locally developed set of photographs and had participants view a broader range of facial expressions in one

and the same task. By doing this, a setting was created in which specific emotion effects had an optimal chance to appear.

Contrary to our expectations, the ERP correlates for crying faces did not substantially differ from those for the other emotional faces, but crying faces did show slightly different ERP waveforms than neutral faces. Crying expressions evoked longer peak-to-peak latencies than neutral expressions in the right occipito-temporal area and at vertex, and elicited a higher peak-to-peak amplitude than neutral expressions in both left and right occipito-temporal areas and at vertex. These results suggest that crying faces mobilized sustained attention, activated a larger neural network or demanded enhanced perceptual processing in comparison with neutral faces. However, this enhanced activity was not specific for crying faces. Crying expressions did not elicit fundamentally different brain processes than expressions of the basic emotions. Therefore, it can be concluded that the processing of emotional expressions in general demands extended attention (e.g. Eimer & Holmes, 2002; Holmes et al., 2003; Sato et al., 2001; Vuilleumier & Schwartz, 2001). As suggested by Sato et al. (2001), this increased activation may enhance the perceptual awareness of emotional stimuli, which makes sense given that the accurate recognition of emotional expressions is important for human adaptation and survival.

Several researchers (e.g. Cuthbert et al., 2000; Lane, Chua, & Dolan, 1999; Lang et al., 1993) have postulated that responses to emotional stimulation, including brain processes, are affected by the fundamental dimensions valence and arousal. Valence refers to the direction of emotional activation (approach versus avoidance), whereas arousal is proposed to refer to the intensity of this activation. The results of the post-hoc comparisons of the present study suggest that the rated arousal, which opposes neutral expressions against emotional expressions, but not the rated valence of the expressions influenced the brain processes. Similarly, Balconi and Pozzoli, (2003) showed that expressions which elicited intense feelings (i.e., anger, fear and surprise) resulted in a more negative peak at approximately 230 ms than expressions which were experienced as less involving and intense (happiness and sadness). However, our covariance analyses revealed that the rated arousal did not influence the evoked ERP waveforms at all, whereas the rated valence did adjust some of the emotion effects.

A shortcoming of the previous studies (Batty & Taylor, 2003; Donkers et al., 2001; Eimer & Holmes, 2002; Eimer et al., 2003; Herrmann et al., 2002; Holmes et al., 2003; Krolak-Salmon et al., 2001; Stekelenburg & De Gelder, 2004) and the present study as well is that they can only answer the question what kind of brain processes facial expressions *can* elicit, and not what kind they typically *do* elicit in real life (Ekman, 1993). Research until now has only used posed expressions, but there is no guarantee that these facial expressions are encountered in real everyday life. Posed expressions might be exaggerated or stylized and as a consequence the differences in ERP correlates to the different facial expressions

might have been more pronounced. Hence, it is important that future studies utilize photographs of spontaneous facial expressions as stimulus material. Furthermore, in real life, people usually have a variety of context information at their disposal that determines the meaning of the expression (Carroll & Russell, 1996). These additional sources of information might codetermine the perceptual processing of facial expressions (Posamentier & Abdi, 2003). Unfortunately, due to practical constraints, it is impossible to examine ERP correlates in response to facial expressions perceived in real-life settings. Therefore, it is important to integrate ERP data with other behavioral measures.

In sum, the present data support a model of automatic, rapid processing of emotional facial expressions. The N170 and VPP appeared not only to reflect the global processing of face stimuli but also the early processing of the facial expression. Future research should try to establish which factors determine the (failure of) occurrence of emotion effects in these face-specific components by employing different tasks and sets of photographs. Based on the forthcoming results, the theoretical models on face perception of Bruce and Young (1998) and of Haxby et al. (2002) can be further developed.

The most important conclusion of the present study is that crying expressions do not elicit fundamentally different early brain-processes than expressions of basic emotions. Both expressions of basic emotions and crying appeared to boost perceptual processing in comparison with neutral expressions, which is consistent with the idea that emotional facial expressions play a crucial role in social interactions. This is not to say that crying might not elicit different and possibly stronger behavioral responses than other emotional expressions as suggested by Cornelius and Lubliner (2003) and by Hendriks and Vingerhoets (submitted). Possibly, these differences in social reactions are only reflected in later ERP correlates, that is, when a more elaborated processing of the facial expressions has taken place (cf. Eimer et al., 2003). In short, crying should be regarded as a compelling communicative signal, which is important for the human species to survive.

# CHAPTER 7
# General discussion and conclusions

## AIM OF THE THESIS

The objective of the present thesis was to get a better insight into the functions of adult crying. More specifically, the research reported aimed to determine whether crying facilitates the recovery of psychological and physiological homeostasis after distress in the crying individual him/herself (*intrapersonal consequences*, Chapters 2 and 3), and/or whether crying is designed to communicate the need for help and to stimulate other people in the social environment to offer this help (*interpersonal consequences*, Chapters 4 through 6).

## MAIN FINDINGS

### Intrapersonal consequences of crying

In order to determine the effects of crying on the crying person him/herself a study was performed in which 60 female participants watched a neutral film and an emotionally arousing film. The participants had to indicate whether and when they cried and whether they suppressed their tears during the emotionally arousing film. In Chapter 2, the effects of crying and of the suppression of tears on mood and pain perception were reported. The results demonstrated that neither crying nor the suppression of tears substantially changed the self-reported mood or pain perception from before to after the film. Although there was an indirect indication that crying partially neutralized the experienced distress, the findings failed to support the hypothesis that tears facilitate the recovery of homeostasis via their short-term effects on mood and pain perception. We did reveal a relationship between crying behavior and pain perception across measurements (i.e., averaged over before and after the film), which might indicate that a high general tendency to cry (as a stable characteristic of personality) is associated with a higher pain tolerance.

Chapter 3 addressed the influence of crying on the recovery of physiological homeostasis. To this purpose, seven physiological parameters were measured while the participants watched the neutral film and the emotionally arousing film. Different from non-crying participants, crying participants demonstrated an increase in heart rate and respiratory sinus arrhythmia and a decrease in respiration rate just before they started to cry. After the onset of the crying episode, heart rate began to drop. These findings indicate that the shedding

of emotional tears was associated with a vagal rebound mechanism that neutralized the sympathetic drive to the heart. However, the timing of the physiological changes implied that crying was rather a result than the cause of this rebound mechanism.

To summarize, our results failed to support the notion that crying results in emotional catharsis. In addition, no evidence was found for the hypothesis that the shedding of emotional tears speeds up the recovery of physiological homeostasis.

**Interpersonal consequences of crying**

Chapters 4 through 6 dealt with the social reactions to the crying of others as examined in three separate studies. Chapter 4 described the results of a scenario study. 530 individuals completed a questionnaire containing the descriptions of six different situations in which the respondent is asked to imagine that s/he encounters a crying person or a non-crying person. The results revealed that participants judged a crying person as less positive and more emotional than a non-crying person, experienced more negative feelings and less sympathy in the presence of a crying person than a non-crying person, but gave more emotional support to and expressed less anger toward a crying person than to(ward) a non-crying person. Furthermore, these social reactions to crying were strongly moderated by the valence of the situation. Empirical support was found for the idea that crying is an alarming signal with a high potential to elicit support and care-taking behavior in others. This especially appeared to hold in negative situations in which crying is probably deemed appropriate.

In Chapter 5, the social reactions to crying expressions as compared to other facial expressions were addressed. One hundred and four participants rated photographs of crying, neutral, anger, and fear faces in terms of person perception, experienced emotions, and overt behavior. Crying individuals, as compared to individuals with other facial expressions, were perceived as less emotionally stable and aggressive. Additionally, they elicited more feelings of sadness, and evoked more emotional support, less avoidance behavior and less expressions of happiness in others. These findings once more confirmed the hypothesis that crying is a compelling communicative signal designed to elicit empathy and emotional support.

The study described in Chapter 6 examined the cortical processing of different facial expressions, including crying. Twenty-five participants viewed photographs of faces depicting neutral, crying, non-crying, angry, fearful and laughing expressions while performing an implicit processing task (i.e., sex discrimination). No clear differences were found between the early ERP-components N170 and VPP evoked by crying faces and those evoked by the other emotional faces. The ERP results did suggest that both crying expressions and expressions of basic emotions boosted perceptual processing in comparison with neutral

expressions. This is consistent with the idea that all emotional facial expressions, including crying, play a crucial role in social interactions.

In sum, although we hardly found any differences in brain activity reflecting the early processing of facial expressions, abundant support was found for the hypothesis that crying is a communicative signal designed to convey the need for help and to stimulate other people in the social environment to offer this help.

## THEORETICAL AND METHODOLOGICAL CONSIDERATIONS

### Intrapersonal consequences of crying

Although it was found that the shedding of emotional tears was associated with a vagal rebound mechanism neutralizing the sympathetic drive to the heart, the results concerning the timing of these physiological changes strongly suggested that this rebound mechanism started before the onset of crying. In other words, tears are more likely just a sign that a temporary parasympathetic overcompensation has taken place (Bindra, 1972; Efran & Spangler, 1979; Gross et al., 1994), and do not themselves instigate an increase in parasympathetic nervous system activity (Rottenberg et al., 2003). It is, however, still possible that crying is not just an accidental epiphenomenon, but instead reinforces the parasympathetic rebound mechanism.

A common idea, especially in the popular press and clinical literature, is that crying positively influences someone's health and well-being (Cornelius, 1986, April; Vingerhoets & Scheirs, 2001). According to Vingerhoets and colleagues (Vingerhoets et al., 2000; Vingerhoets & Scheirs, 2001), there exist two major ways to empirically explore the relationship between the shedding of emotional tears and health: (1) by designing studies which focus on the immediate psychobiological effects of crying, and (2) by performing studies that address the relationship between crying frequency or proneness and health status. The findings of the present thesis provide useful information concerning both lines of research. First of all, our film study revealed that crying did not speed up the recovery of psychological of physiological homeostasis. In contrast, the results for pain perception did suggest that there might be a positive relationship between crying frequency (as a personality feature) and pain tolerance. Based on the crying behavior during the emotionally arousing film, groups of participants could be formed that differed in pain perception both before and after the film. Since Labott and Martin (1987) have demonstrated that crying during a sad film was associated with the general tendency to cry, we concluded that the general tendency to express experienced distress through crying might be associated with a better coping with pain in the long run. However, the precise nature of such a relationship still has to be uncovered in future studies.

### Interpersonal consequences of crying

Both studies on the social reactions to crying revealed that crying elicits emotional support from others. A logical subsequent and interesting question is what motivates people to help a crying person. The answer to this question may be found

in the emotions people experience when they are exposed to a crying person. According to Batson et al. (1983), people can have two different emotional responses to seeing another person suffer, namely personal distress and empathy. Whereas empathy might be regarded an altruistic motivation to help, the reduction of personal distress might be considered as an egoistic motivation (Batson et al., 1983). Following this argument, the scenario study suggests that people help a crying person for an egoistic instead of an altruistic reason, since participants reported more negative feelings and less sympathy in the presence of a crying person than a non-crying person. In contrast, using photographs as stimuli, it was shown that crying faces mainly elicited feelings of sadness (i.e., empathy) and fewer feelings of discomfort and aversion indicating that participants most likely tend to help a crying person for altruistic reasons. It is important that future research focuses more explicitly on whether people help a crying person for egoistic or for altruistic reactions.

A possible explanation for the contradictory results might be found in the different social contexts in which the crying occurred. In the scenario study, the person always cried in a public place with other people present, while in the photograph study participants were instructed to imagine they were alone in a room with the crying person. Probably, people experience more feelings of awkwardness when another person cries in public rather than in private (Hendriks, Nelson et al., submitted) resulting in a more egoistic motivation to help the crying person.

One may also speculate that the reactions of others to a crying person depend on whether they perceive the crying as appropriate or not. Anecdotal evidence has suggested that tears that are considered as unjustified or insincere may evoke negative reactions such as frustration and irritation in others and even may be considered as blackmail (e.g., Frijda, 1986, 1997; Hill & Martin, 1997; Nelson, 2000). As an example, crying on the job is often considered as inappropriate (Hoover-Dempsey et al., 1986), and Wagner et al. (1997) did indeed find that medical students who cried at work were sometimes ridiculed, looked at with contempt or screamed at by their colleagues. In the photograph study, participants did not receive any information concerning the reason why the person cried. It is very well possible that they just assumed that the crying person had a very good reason for this behavior, which resulted in mainly feelings of empathy. In contrast, the situation in which the person cried was known in the scenario study. The respondents might have considered the crying unjustified leading to the experience of more negative feelings. The perceived appropriateness might also explain why in the scenario study participants responded more positively to a person who cried in a negative situation than in a positive situation. Possibly, crying in a positive situation is generally perceived as less appropriate than crying in a negative situation.

Additionally, sex role stereotypes might affect the appraisal of crying men and crying women in terms of appropriateness (Labott et al., 1991; Zillmann et al.,

1986). One of the most pervasive stereotypes is still that of the crying woman alongside the man who knows how to control his feelings and to suppress his tears (Bekker & Vingerhoets, 2001). The prevalence of this stereotype might implicate that the crying of women results in more interpersonal benefits than the crying of men. However, the present thesis failed to reveal substantial differences in the social reactions to a crying man and a crying woman. As suggested by Labott et al. (1991), sex role expectations might have changed over the last few years meaning that nowadays it is more accepted and appreciated that a man expresses his emotions, for instance, through crying. A crying man nowadays may be considered as more attractive, since he shows his sensitivity, whereas a man who is not able or willing to cry when the situation asks for it is more disliked.

**Functions of adult crying**

The findings of the present thesis revealed that crying for sure evokes positive reactions from the social environment such as help and emotional support. This indicates that crying is an important attachment behavior that continues to be effective throughout life. Apparently, the shedding of emotional tears is not just a behavior that serves to facilitate the bond between child and parents (Ainsworth et al., 1978; Bowlby, 1969). It also promotes social cohesion among adults (cf. Hazan & Zeifman, 1999), which is important for a social animal such as the human being.

Less evidence was found for the hypothesis that crying restores our emotional and physiological balance after distress. Maybe, as suggested by Cornelius (2001), the alleged positive effects of crying on the crying person him/herself only occur when the shedding of tears leads to a positive change in the situation. People from the social environment might alleviate someone's distress by providing comfort or by distracting attention away from the problem (Diamond, 2001). This implies that crying does not by definition (e.g., via biopsychological pathways) lead to tension reduction and/or emotional relief, but that the social context in which the crying occurs, in particular the reactions of others, largely determines its intrapersonal consequences. For example, a crying individual might only feel better afterwards if his or her tears result in emotional support and understanding rather than when s/he meets disapproval and negative reactions.

Furthermore, it is important to note that present thesis did not distinguish between different forms and/or intensities of crying. To date, there is still no consensus whether or not crying should be considered a unitary phenomenon (Vingerhoets et al., 2000). Williams and Morris (1996), for example, have distinguished between a form of crying that is relatively intense, long lasting, and difficult to control or stop, and a second form of crying that is more heterogeneous and easier to control. Based on attachment theory, Nelson (1998, 2000) has also distinguished two types of crying, namely protest crying and sad crying. The purpose of protest crying is to undo a loss and bring about a reunion (Bowlby, 1960). There is a lot of energy behind such a cry, and it is often accompanied by

vocalized crying as opposed to silent weeping. Crying of sad despair has more of a quiet energy and signifies the surrender to or acceptance of a loss. These different kinds of crying may of course have implications for the proposed intra- and interpersonal consequences of tears. Concerning the intrapersonal effects, it has been suggested that crying must have a minimum intensity or duration before it can improve someone's mood (Kraemer & Hastrup, 1988). This would imply that only the intense, long-lasting kind of crying distinguished by Williams and Morris (1996) has positive effects on the crying person him/herself. Focusing on the interpersonal effects, Nelson (1998, 2000) has argued that only sad crying arouses sympathetic responses in others, whereas protest crying is more likely to elicit irritation or apathy. In short, it is important that future research first establishes whether different kinds of crying indeed exist, and, if that proves to be the case, subsequently carefully examines the possibly differential consequences of these different kinds of crying.

## LIMITATIONS OF THE PRESENT RESEARCH

It is important to note that our film study on the intrapersonal effects of crying (Chapter 2 and 3) was only quasi-experimental. Individuals were not randomly assigned to a crying and a non-crying condition but rather were instructed to respond as natural as possible. Although our findings revealed that crying and non-crying participants did not differ in baseline physiological arousal, it is unclear whether the crying and non-crying individuals differed systematically on other variables (e.g., personality, coping, etc.) besides their crying behavior. Therefore, it remains to be examined what the precise contribution of the crying response is to the differences between the crying and the non-crying group (Scheirs & Sijtsma, 2001).

Furthermore, the generalizability of the results of the film study is limited because only women participated. Research has consistently shown that women cry more often, more intensely and for a longer period than do men (Vingerhoets & Scheirs, 2000). As suggested by Martin et al. (1993), crying may represent quite different psychological processes in males and females, which implicates that crying may have differential effects depending on sex. Replication of our film study in a male sample is additionally important because research has revealed sex differences in pain perception (e.g., Nyklícek et al., 1999; Weaver & Zillmann, 1994) and in physiological responses to sad film-fragments (Fredrickson et al., 1992, October).

To measure the social reactions to crying, three empirical studies were performed. In two of these studies (Chapter 4 and 5), participants either read vignettes about meeting a crying or a non-crying person or watched photographs of several facial expressions including crying faces. Subsequently, they were asked to indicate how they would perceive the (non-)crying person, how they would feel in presence of this person and how they would respond behaviorally toward this person. Probably, behavior in real everyday-life cannot be predicted on the basis of

the responses to simply reading a vignette or watching a photograph (e.g., Lanza & Carifio, 1992; Parkinson & Manstead, 1993). Rather, one may assume that these methods mainly measure social desirable reactions, stereotypes, naïve theories and social representations instead of actual behavior. However, the methodology was adequate for the present purposes because it provides an important first step in generating hypotheses concerning the actual behavior in response to a crying person.

A shortcoming of the studies using photographs of facial expressions as stimuli (Chapter 5 and 6) is that posed instead of spontaneous facial expressions were depicted. Posed expressions might be exaggerated or stylized in a manner that the expressions are most likely to be understood by observers (Russell, 1994). As a consequence, the differences in social reactions to these facial expressions might have been more pronounced than they would be in real life. Additionally, participants were asked to respond to the expressions in an experimental situation devoid of other contextual information sources. In real life, people usually have a variety of context information at their disposal to determine the meaning of a facial expression (Carroll & Russell, 1996; Fernández-Dols, 1999). This derived meaning might subsequently influence the social reactions to facial expressions.

## RECOMMENDATIONS FOR FUTURE RESEARCH

Based on the conclusions of the present project, the following general recommendations can be made for future research on crying. An important first step is to determine whether there exist different kinds of crying. However, the question is which criteria should be used to differentiate between different forms. One could, for instance, focus on the situation or emotion that elicits the crying, on the purpose of the crying spell (e.g., Nelson, 1998, 2000) or on the characteristics of the crying itself in terms of intensity and duration (e.g., Williams & Morris, 1996). Therefore, it is important that scientists reach consensus concerning the importance of the different criteria and, subsequently look into possible differential consequences of different kinds of crying.

Regarding the intrapersonal consequences of shedding emotional tears, the effects of crying and the inhibition of crying need to be disentangled. It might be that the found differences between crying and non-crying participants do not reflect the effects of crying in crying participants but rather reveal the effects of suppressing one's tears in non-crying participants. More generally, it is important to take into account the different strategies people adopt to manage their emotional expressions when faced with emotional events. Gross (1998) has distinguished antecedent-focused emotion regulation (for instance, reappraisal) from response-focused emotion regulation (for instance, suppression), and has suggested that these different forms have different consequences for psychological and physiological well-being. It would be illuminating to perform an experiment in which more attention is paid to the mechanisms that people adopt to withhold from crying. For example, one might

instruct respondents to cry, to suppress their tears or to reappraise the emotional event in such a way that they feel no emotion. In addition, a control group should be included that receives no instructions. Subsequently, the actual behavioral responses of these groups should be measured and the effects of these responses on mood and physiological parameters should be determined.

Furthermore, it is important that the physiological correlates of crying that have been found in laboratory experiments are replicated in real life. As suggested by De Geus and Van Doornen (1996), the physiological mechanisms in response to laboratory stressors might differ from those in response to real-life stress. Nowadays, several ambulatory devices are available to measure among other things sympathetic and parasympathetic nervous system activity. It would be interesting to find out whether crying in real life is also associated with a parasympathetic rebound mechanism and whether the intrapersonal effects depend upon the effects of crying on the social environment. However, an important consideration is whether crying is common enough in everyday life to make this kind of ambulatory research feasible. In addition, it will be a challenge to design an ethically acceptable procedure.

Since crying seldom occurs in a social vacuum, it is important to replicate the here reported interpersonal consequences in studies in which the actual behavior of individuals is measured. It would be very interesting to have participants interact with a confederate in several situations and to observe how the participants respond to the (crying) behavior of this confederate. Unfortunately, it is very time-consuming to systematically vary several variables in one behavioral experiment. A good alternative might be to use film fragments of interactions in several social contexts and have participants respond to these fragments. In this way, research could also determine the influence of the perceived appropriateness of crying on the social reactions, and could focus on whether people help a crying person for egoistic or for altruistic reasons.

Additionally, the social reactions to crying need to be compared with reactions to other emotional expressions, especially sad expressions without tears. Crying and sad faces both seem to communicate the message that one is feeling sad and in need of help (Cornelius & Lubliner, 2003; Cornelius et al., 2000; Yik & Russell, 1999). The data of Cornelius and his colleagues (Cornelius & Lubliner, 2003; Cornelius et al., 2000), however, suggest that tearful faces and the same faces without tears may elicit some intriguing different social reactions. It would be interesting to find out whether crying faces are a more compelling help-soliciting signal than sad faces without tears. This would imply that tears are an essential component in eliciting caretaking behavior in others and that putting up a sad face does not suffice.

Finally, it would be interesting to combine the study on intrapersonal and interpersonal consequences of crying. In this way, it could be determined whether the recovery of psychological and physiological homeostasis after a crying episode depends upon the reactions from people in the social environment. More precisely,

one might expect that receiving comfort and emotional support will result in more positive intrapersonal consequences than social disapproval and being left alone.

## CONCLUSION

The objective of the present investigations was to get a better insight into the functions of adult crying. Since these functions can be derived from the specific consequences of crying within the current environment (Keltner & Gross, 1999), several studies were performed to examine the effects of the shedding of emotional tears on the crying person him/herself and on the social environment. It was concluded that crying is functional because it efficiently elicits help and emotional support from others when needed. Less empirical support was found for the hypothesis that crying restores our physiological balance after distress. In other words, crying appears to have mainly interpersonal benefits and should as such be considered an emotional expression that is important for social cohesion and human adaptation.

# SAMENVATTING

## INLEIDING

Huilen om je emoties te uiten is een universeel en typisch menselijk gedrag (Vingerhoets & Cornelius, 2001; Vingerhoets et al., 2000). Geen enkel ander dier is in staat om emotionele tranen te laten en huilen wordt dan ook beschouwd als een verschijnsel dat uniek is voor mensen (Bindra, 1972; Vingerhoets et al., 2000). Volgens Vingerhoets et al. (2000) huilen mensen voornamelijk bij verlieservaringen of wanneer ze niet weten hoe ze met een situatie moeten omgaan. Situaties die vaak huilgedrag oproepen, zijn het verlies van een dierbare, het verbreken van een relatie of conflicten binnen een relatie, verlies van werk of status en het kijken naar verdrietige of ontroerende films/televisieprogramma's (Nelson, 1998, 2000; Vingerhoets et al., 2000; zie ook bijdragen aan Vingerhoets & Cornelius, 2001). Hoewel verschillende emoties kunnen leiden tot tranen, gaat huilen vaak gepaard met gevoelens van machteloosheid in combinatie met verdriet of rouw (Nelson, 1998, 2000; Vingerhoets et al., 2001; Vingerhoets et al., 2000).

Opmerkelijk genoeg is er tot op heden weinig systematisch onderzoek gedaan naar huilen. Al sinds Darwin theoretiseren wetenschappers over het waarom van huilen, maar deze vraag is nog niet beantwoord. In de literatuur wordt wel een onderscheid gemaakt tussen twee mogelijke functies van huilen (Gross et al., 1994; Vingerhoets et al., 2000). Huilen zou allereerst de functie hebben om de fysiologische en psychologische balans na stress te herstellen. Daarnaast is geopperd dat huilen vooral bedoeld is om naar andere mensen te communiceren dat men hulp of troost nodig heeft en om anderen te stimuleren deze hulp of troost te bieden. Het doel van het huidige proefschrift was om een antwoord te vinden op de vraag wat de functie is van huilen door te onderzoeken wat voor invloed huilen heeft op de huilende persoon zelf (*intrapersoonlijke gevolgen*) en op andere mensen in de sociale omgeving (*interpersoonlijke gevolgen*).

## INTRAPERSOONLIJKE GEVOLGEN VAN HUILEN

Veel mensen gaan ervan uit dat huilen voor emotionele opluchting zorgt en leidt tot vermindering van spanningen. Het achterliggende idee is dat tranen het resultaat zijn van sterke negatieve gevoelens die op een of andere manier geuit moeten worden (Cornelius, 2001). Tranen representeren het overstromen van emoties die een bepaalde kritische grens overschrijden. Door te huilen wordt energie vrijgelaten die werd gemobiliseerd tijdens stress en hierdoor wordt voorkomen dat emoties zich opstapelen (Sadoff, 1966). Daarentegen zou bij het onderdrukken van

tranen de emotionele spanning tot uiting komen in verschillende fysieke en psychische klachten (Cornelius, 2001; Groen, 1957).

Een manier om de effecten van huilen op het lichamelijk functioneren te onderzoeken is door te kijken naar de gevolgen van huilen voor het functioneren van het autonome zenuwstelsel. Het autonome zenuwstelsel bestaat uit twee delen, namelijk het sympathische en parasympathische deel. Deze twee delen hebben in hoofdzaak een aan elkaar tegengestelde werking en normaal gesproken zijn de twee delen met elkaar in evenwicht. Het ervaren van intense emoties gaat gepaard met hoge niveaus van sympathische activiteit. Verscheidene onderzoekers (onder andere Bindra, 1972; Gross et al., 1994; Kraemer & Hastrup, 1988) veronderstellen nu dat huilen samengaat met parasympathische mechanismen, die deze hoge niveaus van sympathische activiteit verlagen om zodoende de balans binnen het lichaam te herstellen. Hoewel de traanklieren geactiveerd kunnen worden door zowel het parasympathische als het sympathische zenuwstelsel, is voor huilen de stimulatie van parasympathische vezels in de zevende hersenzenuw noodzakelijk (Gross et al., 1994; Rottenberg et al., 2003; Van Haeringen, 2001). Het idee is dat tranen ofwel het gevolg zijn van een tijdelijke parasympathische overcompensatie (Bindra, 1972; Efran & Spangler, 1979; Gross et al., 1994) ofwel zelf de stijging in parasympathische activiteit veroorzaken (Rottenberg et al., 2003).

In de Hoofdstukken 2 en 3 van dit proefschrift werd een studie naar de intrapersoonlijke gevolgen van huilen beschreven. Om te bepalen wat voor effecten huilen heeft op de huilende persoon zelf keken 60 vrouwelijke deelnemers naar een neutrale en een emotionele film keken. De deelnemers moesten aangeven of en wanneer ze huilden en of ze hun tranen onderdrukten tijdens de emotionele film. In Hoofdstuk 2 werden de effecten van huilen en het onderdrukken van tranen op iemands stemming en pijnwaarneming gerapporteerd. De resultaten lieten zien dat noch huilen noch het onderdrukken van tranen de zelfgerapporteerde stemming of pijnwaarneming aanzienlijk veranderden. Hoewel er een aanwijzing was dat huilen ervaren onrust neutraliseerde, bevestigde de resultaten niet de hypothesis dat tranen het herstel van het emotioneel evenwicht bevorderen. Huilgedrag en pijnwaarneming bleken wel samen te hangen in die zin dat een hoge gemiddelde pijntolerantie over metingen vóór en na de film positief samenhing met huilen tijdens het kijken van de film.

Hoofdstuk 3 behandelde de invloed van huilen op het herstel van de fysiologische balans. Zeven fysiologische parameters (hartslag, diastolische bloeddruk, systolische bloeddruk, huidgeleiding, ademhaling, respiratoire sinus arrhythmia en pre-ejection period) werden gemeten terwijl de vrouwelijke deelnemers naar de neutrale film en de emotionele film keken. Anders dan bij niet-huilende personen, namen bij huilende deelnemers vlak voor de huilbui de hartslag en de respiratoire sinus arrhythmia toe en de ademhaling af. Nadat de huilbui begonnen was, nam de hartslag weer af. Deze resultaten toonden aan dat huilen samengaat met parasympathische mechanismen die de sympathische invloed op het

hart neutraliseren. Oftewel huilen lijkt het herstel van de fysiologische balans te bevorderen. Wanneer evenwel de timing van deze fysiologische veranderingen in ogenschouw werd genomen, moest worden geconcludeerd dat huilen eerder een gevolg dan de oorzaak is van dit parasympathisch mechanisme.

**INTERPERSOONLIJKE GEVOLGEN VAN HUILEN**

Naast de gevolgen van huilen voor de huilende persoon zelf, hebben onderzoekers aandacht besteed aan de invloed van huilen op de sociale omgeving (Vingerhoets et al., 2000). Zo speculeerde Kottler (1996) dat huilen uniek is voor mensen, omdat menselijke baby's zich relatief langzaam ontwikkelen en mensen dus voor een aanzienlijk lange tijd afhankelijk zijn van de hulp van anderen om voor hen te zorgen. Huilen is een emotionele uitdrukking die aan anderen en aan de huilende persoon zelf laat zien dat hij/zij kwetsbaar is, lijdt en hulp of troost nodig heeft (Fridlund, 1992; Frijda, 1997; Yik & Russell, 1999). De belangrijkste functie van huilen is mogelijk het stimuleren van anderen om te helpen en het oproepen van aandacht, medeleven en steun (Frijda, 1997; Kottler & Montgomery, 2001; Vingerhoets et al., 2000). Daarnaast kunnen tranen het signaal afgeven dat iemand met rust gelaten wil worden en kunnen ze agressieve neigingen van potentiële aanvallers temperen (Kottler & Montgomery, 2001).

Vanuit weer een ander theoretisch perspectief wordt huilen gezien als een belangrijk hechtingsgedrag (Nelson, 1998, 2000). Hechtingsgedragingen zijn bedoeld om zorgzame reacties op te roepen bij belangrijke anderen (Bowlby, 1969). Onderzoek heeft laten zien dat huilen een aangeboren gedrag is met als functie het vragen om en het zich verzekeren van de beschermende en verzorgende aanwezigheid van opvoeders (Bell & Ainsworth, 1972; Bowlby, 1969; Cassidy, 1999; Zeifman, 2001). De veronderstelling is dat tranen gedurende het hele volwassen leven van een persoon in staat blijven om zorgzaam gedrag bij anderen op te roepen (Bowlby, 1969; Nelson, 1998, 2000).

In de Hoofdstukken 4 tot en met 6 van dit proefschrift werden drie onderzoeken gerapporteerd die de sociale reacties van anderen op huilen bekeken. Hoofdstuk 4 beschreef de resultaten van een scenario studie. 530 personen beantwoordden vragen na het lezen van zes verschillende situatiebeschrijvingen waarin de hoofdpersoon een huilende of een niet-huilende persoon tegenkomt. De resultaten lieten zien dat deelnemers een huilende persoon minder positief en meer emotioneel beoordeelden dan een niet-huilende persoon en dat ze meer negatieve gevoelens en minder sympathie ervoeren in de aanwezigheid van een huilende persoon dan in het gezelschap van een niet-huilende persoon. Tegelijkertijd gaven deelnemers meer emotionele steun aan en uitten ze minder boosheid tegen een huilende persoon dan een niet-huilende persoon. Deze sociale reacties op huilen werden sterk beïnvloed door de emotionele geladenheid (positief of negatief) van de situatie. Er werd empirische steun gevonden voor het idee dat huilen een alarmerend signaal is met een hoge potentie om steun en troostend gedrag bij

anderen op te roepen. Dit was met name het geval bij negatieve situaties waarin het huilen waarschijnlijk gepast werd gevonden.

Hoofdstuk 5 behandelde de reacties op huilende gezichten vergeleken met andere gezichtsuitdrukkingen. 104 deelnemers beoordeelden foto's van huilende, neutrale, boze en angstige gezichten in termen van persoonperceptie, ervaren emoties en gedrag. Vergeleken met de andere gezichtsuitdrukkingen werden personen met een huilend gezicht minder emotioneel stabiel en minder agressief gevonden. Daarnaast riepen huilende gezichten meer gevoelens van verdriet op dan de andere gezichtsuitdrukkingen. Wat betreft het gedrag bleek dat deelnemers geneigd waren meer emotionele steun te geven, minder vermijdingsgedrag te vertonen en minder blijdschap te tonen bij huilende dan bij niet huilende personen. Deze bevindingen bevestigden opnieuw de hypothese dat huilen een sterk communicatiesignaal is dat bedoeld is om empathie en emotionele steun op te roepen.

De studie die werd beschreven in Hoofdstuk 6 onderzocht de verwerking in de hersenen van verschillende gezichtsuitdrukkingen waaronder huilen. 25 personen keken naar foto's van gezichten met een neutrale, huilende, niet-huilende (dat wil zeggen een huilende uitdrukking zonder tranen), boze, angstige en lachende uitdrukking. Tegelijkertijd werd de hersenactiviteit op meerdere lokaties geregistreerd. De resultaten lieten geen duidelijke verschillen zien tussen de vroege verwerkingsstadia bij huilende gezichten en bij andere emotionele gezichten. De resultaten suggereerden wel dat in vergelijking met neutrale uitdrukkingen huilende gezichten en gezichten met andere emotionele uitdrukkingen de perceptuele verwerking stimuleerden. Dit ondersteunt het idee dat alle emotionele gezichtsuitdrukkingen, inclusief huilen, een belangrijke rol spelen in sociale interacties.

## FUNCTIES VAN HUILEN

Huilen is mogelijk essentieel voor de aanpassing en overleving van mensen omdat het twee belangrijke functies vervult. Huilen zou de fysiologische en psychologische balans na stress herstellen en zou andere mensen stimuleren om hulp te bieden wanneer nodig. De resultaten van het huidige proefschrift lieten zien dat huilen zeker positieve reacties oproept in de sociale omgeving zoals hulp en emotionele steun. Dit impliceert dat huilen een belangrijk hechtingsgedrag is dat niet alleen voor hulpeloze baby's van belang is maar dat tijdens het gehele, ook volwassen, leven effectief blijft. Het laten vloeien van tranen versterkt niet alleen de band tussen kind en ouders (Ainsworth et al., 1978; Bowlby, 1969), maar het bevordert tevens de sociale cohesie tussen volwassenen onderling (cf. Hazan & Zeifman, 1999).

Minder bewijs werd gevonden voor de hypothese dat huilen onze emotionele en fysiologische balans na stress herstelt. Huilen tijdens een film had geen effect op de stemming of pijnwaarneming van de persoon en huilen leek

eerder een gevolg dan de oorzaak te zijn van het parasympathische mechanisme dat de fysiologische balans herstelde. Mogelijk vinden de positieve effecten op de huilende persoon zelf alleen plaats wanneer tranen een situatie in positieve zin veranderen (Cornelius, 2001). Mensen in de sociale omgeving kunnen iemands stress verlichten door hem/haar te troosten of af te leiden van het probleem (Diamond, 2001). Dit zou betekenen dat huilen op zich niet per definitie leidt tot spanningsvermindering en/of opluchting, maar dat de sociale context waarbinnen het huilen plaatsvindt grotendeels ook de *intrapersoonlijke* effecten bepaalt. Een huilende persoon voelt zich bijvoorbeeld slechts dan beter als zijn of haar tranen resulteren in emotionele steun en begrip en niet als het huilen wordt afgekeurd.

Kort samengevat: huilen lijkt voornamelijk interpersoonlijke voordelen te hebben, die al dan niet op hun beurt weer kunnen resulteren in gunstige intrapersoonlijke effecten. Huilen is functioneel omdat het efficiënt hulp en emotionele steun oproept bij anderen. Als zodanig kan huilen beschouwd worden als een emotionele uitdrukking die belangrijk is voor het ontstaan en behouden van sociale relaties tussen mensen.

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# CURRICULUM VITAE

Michelle Hendriks was born in Roosendaal on the third of June 1977. In 1995 she graduated at the Getrudis College in Roosendaal. From 1995 to 2000 she studied Psychology at Tilburg University. After obtaining her Master's Degree in Health Psychology, she started to work as PhD student at Tilburg University. During the following four years she performed several studies in order to determine the functions of adult crying. These investigations have resulted in the present thesis, which she finished in August 2004. At the moment, she works as a researcher at Nivel, Netherlands Institute for Health Services Research.

Crying in adults is a ubiquitous and distinctly human form of emotional expression. Although scientists since Darwin have theorized about the purposes of emotional tears, the functional significance of adult crying has yet to become a subject of systematic research. The studies described in this thesis investigated the effects of crying on the crying person him/herself (intrapersonal consequences) and on the social environment (interpersonal consequences).

More specifically, the research reported aimed to determine whether crying facilitates the recovery of physiological and psychological homeostasis after distress in the crying individual him/herself, and/or whether crying is designed to communicate the need for help and to stimulate other people in the social environment to offer this help.